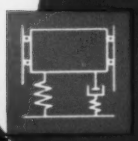
OCTOBER 16, 1958

MACHINE DESIGN

A PENTON PUBLICATION — BIWEEKLY



Vibration Isolation

Contents, Page 3

FARNSWORTH

DRIVE AND CONTROL IDEAS FOR ENGINEERS

Tips on better designing with **FLEXIBLE SHAFTS**

Light Weight and handling ease are two obvious advantages this flexible shaft driven concrete grinder has over conventional portable tool design. Weight of the motor is removed from the operator's hands. S.S.WHITE power drive flexible shafts are ideal whenever there is relative movement between the driven and driving part.

STANDARD S.S.WHITE FLEXIBLE SHAFTS are available "off the shelf" to allow the designer to test the advantages of flexible shafts at low cost. For complete information, write for Bulletin 5801.

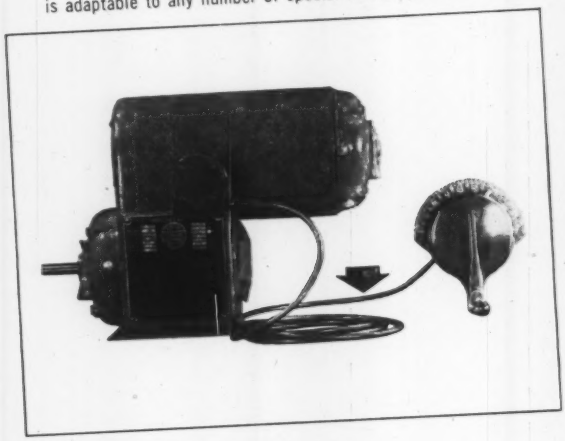
S.S.WHITE also offers engineering service and a comprehensive selection of *flexible shaft* sizes and types to meet specialized design requirements. Complete information in Bulletin No. 5601. (Dept. 4)

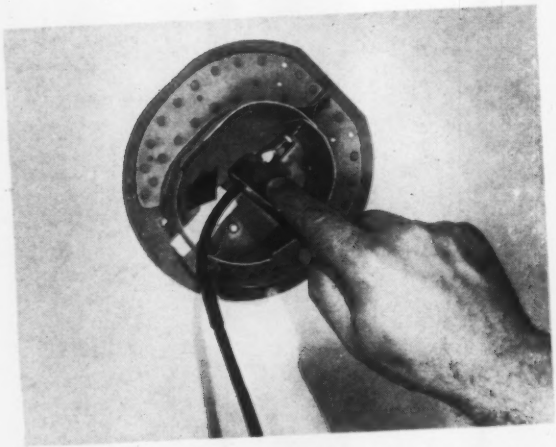
S.S.White

FIRST NAME IN FLEXIBLE SHAFTS

S.S.WHITE INDUSTRIAL DIVISION
10 East 40th Street New York 16, New York
Western Office: 1839 West Pico Blvd., Los Angeles, Calif.

Position Controls To Best Advantage by using S.S.WHITE remote control flexible shafts, as on this fractional horsepower variable speed electric motor. The shaft transmits changes in the setting of the control handle to the motor to allow exact speed changes while motor is in operation. It eliminates alignment problems, reduces number of parts required, saves time and cost in assembly and is adaptable to any number of special motor applications.





Key To universal flexibility of this handy drill unit is a ¼" S.S.WHITE flexible coupling shaft with drill collet attached. Use of the flexible shaft coupling makes unit compact, light and easy to handle. Coupling shafts — flexible shafts without companion casings — meet a wide variety of control and power drive applications.

Useful data on how to select and apply flexible shafts! Write for Bulletin 5601.

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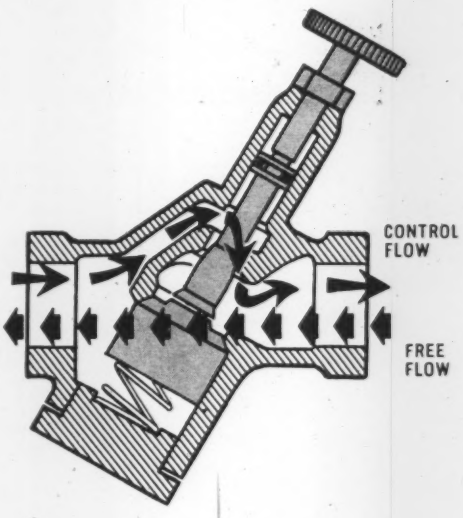
Tranquilize your cylinders

Rx

Ross speed control valves

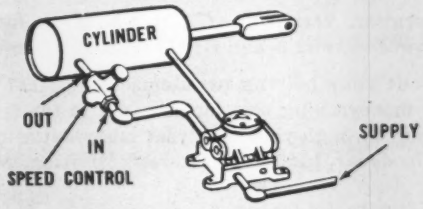


FREE FLOW TO CYLINDER (LEFT)
CONTROLLED FLOW FROM CYLINDER

PRICED WITH THE LOWEST

By keeping full power driving the cylinder but metering the flow from it, you can get smooth, positive and infinitely variable control of the cylinder speed without the problems that come with trying to adjust cylinder movement by varying inlet pressure. This is why speed control valves are so satisfactory for making cylinders act right. And why do so many specify Ross speed controls?

Simply this. When you turn the adjustment screw things don't "just happen." Instead, you force the air to flow through a carefully engineered variable orifice, an orifice designed to create fine shadings of control at both high and low flow rates. And, this performance is yours in a valve that is designed and built to thrive under rough conditions and still be around for a long time. This valve's only moving internal part is its poppet. You can lock its adjustment against tampering. It mounts in any position. Its aluminum alloy body gives heavyweight performance with welterweight bulk. Join the thousands who profit by using Ross speed control valves.



The speed control valve as used between a 4 way valve and a cylinder, shown above, regulates (slows down) the piston rod retraction.

FULL RANGE IN STOCK

3 ADJUSTABLE HEAD STYLES AVAILABLE, KNOB, PIN OR SLOT

ALUMINUM ALLOY BODY

BUBBLE TIGHT POPPET

PIPE SIZE ¼, ⅜, ½, ¾, 1, 1¼

Call your nearby Ross Valve engineer or write us.

Ross OPERATING VALVE CO. **109 East Golden Gate • Detroit 3, Michigan**

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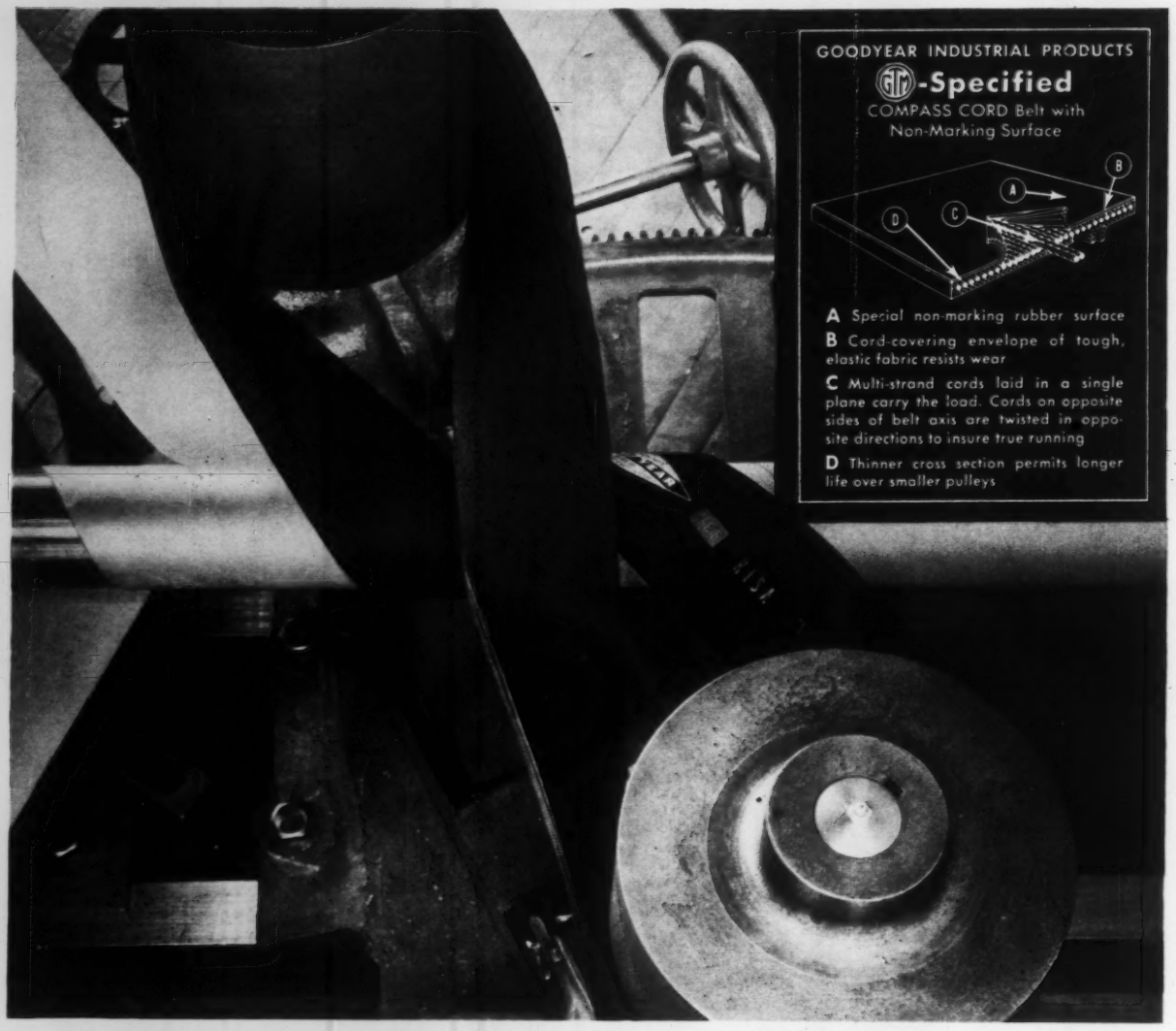
GOODYEAR INDUSTRIAL PRODUCTS
G.T.M.-Specified
COMPASS CORD Belt with
Non-Marking Surface
A
B
C
D
A Special non-marking rubber surface
B Cord-covering envelope of tough, elastic fabric resists wear
C Multi-strand cords laid in a single plane carry the load. Cords on opposite sides of belt axis are twisted in opposite directions to insure true running
D Thinner cross section permits longer life over smaller pulleys

Keeps tube-winder wound up 3 times as long!

Any tube-winder drive is tough. Speed is high. Abrasion is surprisingly severe. The belt must flex continually over small diameters—must negotiate a twisting quarter-turn. So it isn't surprising that previous belts used by this upper New York State machinery maker quickly failed—required replacement all too soon.

But tough drives are routine assignments to the G.T.M.—Goodyear Technical Man. He knew he could better their belt life with rubber-covered COMPASS Cord Belts. They're sinewed with super-tough load-carrying cords for maximum resistance to stretch and abrasion—have the thin cross section which facilitates small-pulley operation. *Result: The G.T.M.'s belts are outlasting their predecessors 2- and 3-1—often better than that.*

What about your belting problems? The first step toward a moneysaving solution is a call to the G.T.M. Contact him through your Goodyear Distributor—or by writing Goodyear, Industrial Products Division, Akron 16, Ohio.

IT'S SMART TO DO BUSINESS *with your Goodyear Distributor. He can give you fast, dependable service on Hose, V-Belts, Flat Belts and many other industrial rubber and nonrubber supplies. Look for him in the Yellow Pages under "Rubber Goods" or "Rubber Products."*

COMPASS CORD BELT BY

GOODYEAR

60½ ANNIVERSARY

THE GREATEST NAME IN RUBBER

Compass—T. M. The Goodyear Tire & Rubber Company, Akron, Ohio

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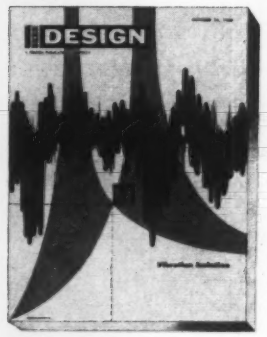

Front Cover: A "moving" cover design created by artist George Farnsworth shows an essentially new technique for vibration isolation. Article by Jerry Ruzicka and Dick Cavanaugh is on Page 114.

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MACHINE DESIGN

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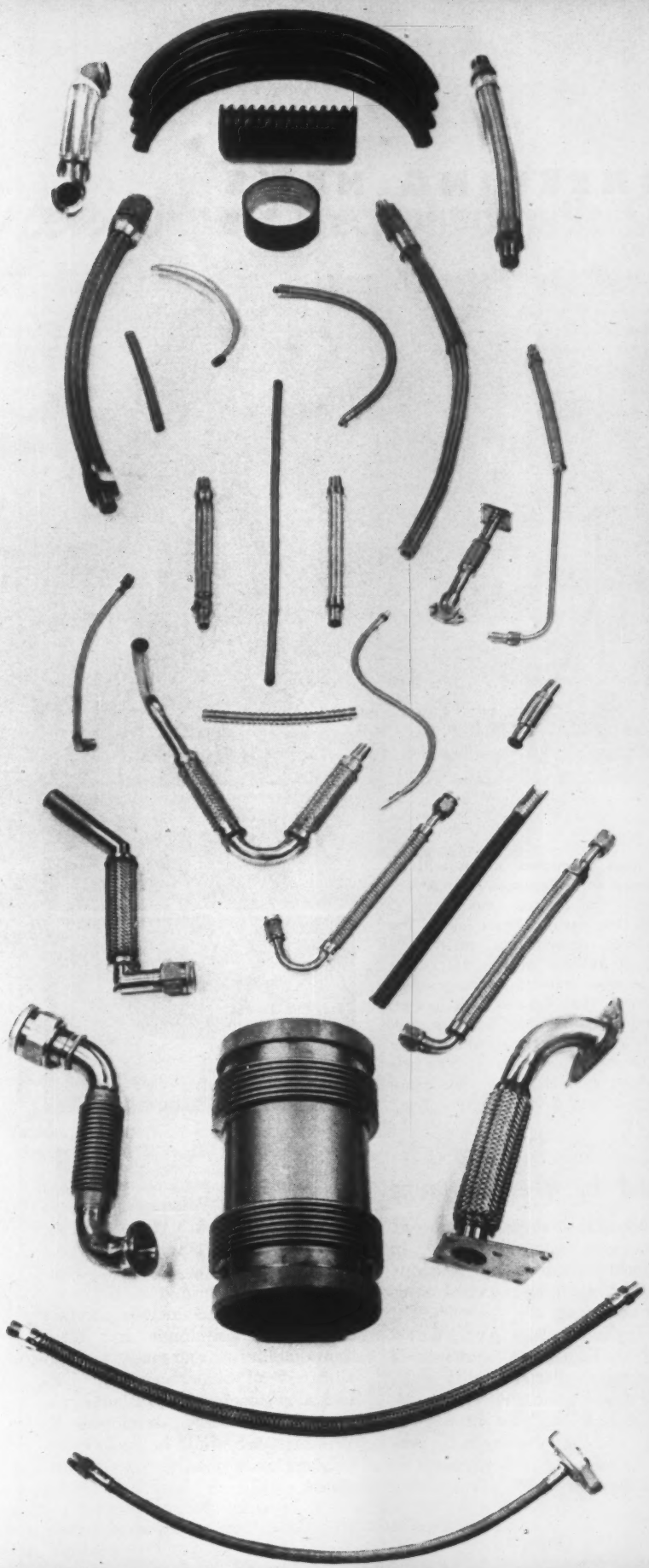

TELL US WHAT THE FLEXIBLE HOSE OR CONNECTOR MUST DO

Our engineers will send you design suggestions that can save you time and money.

Jet aircraft, modern chemical plants, rockets, atomic energy plants have created a new technology that calls for new products. The American Metal Hose Division of The American Brass Company is constantly working with design engineers on special flexible assemblies to meet new problems.

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WHEREVER CONNECTORS MUST MOVE

AMERICAN

FLEXIBLE METAL HOSE AND TUBING

an

ANACONDA®

product

Made by The American Metal Hose Division, The American Brass Company

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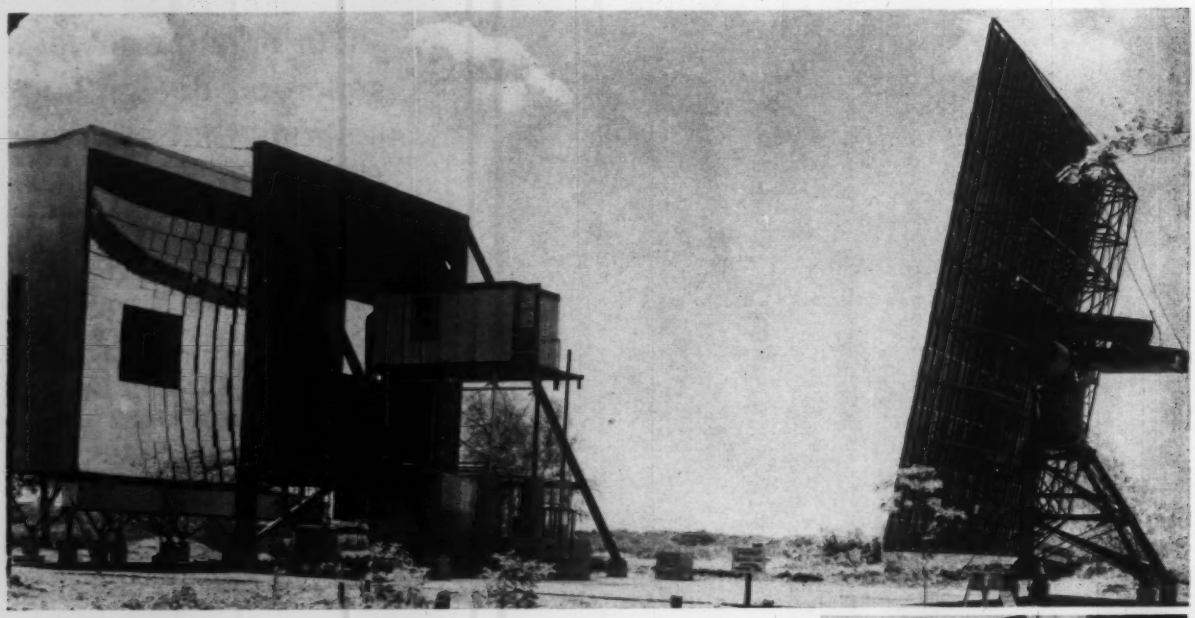
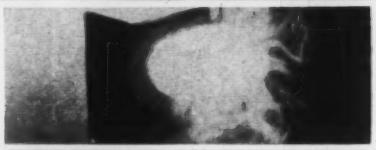
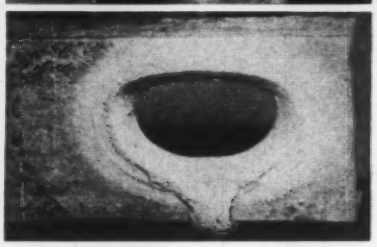
ENGINEERING NEWS







Heat When the Sun Shines

Materials designed to protect soldiers from the heat of nuclear blasts will be tested at 5000-F temperatures in the nation's largest solar furnace. Conceived, developed, and operated by Quartermaster Corps, the optical assembly is a remarkably simple and inexpensive means of producing clean, intense heat. The furnace comprises four major components: Heliostat, concentrator, attenuator, and test chamber. The heliostat, right, consisting of 355 flat mirrors, tracks the sun and reflects rays onto the 180 prefocused concave mirrors of the concentrator, far left. An intensified beam of sunshine is thus focused into a 4-in. test chamber where it is easily capable of burning 4-in. elliptical holes in steel I-beams. The attenuator, mounted between heliostat and concentrator, works like a venetian blind in controlling the amount of radiation used. It also acts as a safety device by automatically closing in event of emergency. The usual testing procedure is to expose material specimens to a brief pulse of intense heat.

Computer Program Pool Proposed by Westinghouse

Offers IBM-704 Sequences As Clearing-House Starter

PITTSBURGH—Major obstacle to the widespread use of digital computers in engineering is the unavailability of programs (trade name for sequence of computer operations for a problem). Developing a typical program may cost a company between $20,000 and $50,000, and may require more time than for the actual solution of a problem. To beat this time and money squeeze, programs are carefully saved in some form suited to the machine being used, such as punched cards or tape recording.

Westinghouse has proposed through J. K. Dillard, manager of the company's electric utility engineering department, that an organization be established for the free exchange of digital-computer programs between various segments of the industry.

"To get the plan started," says Mr. Dillard, "Westinghouse will contribute to such a clearing house . . . eight basic power-system programs for use on IBM-704 computers."

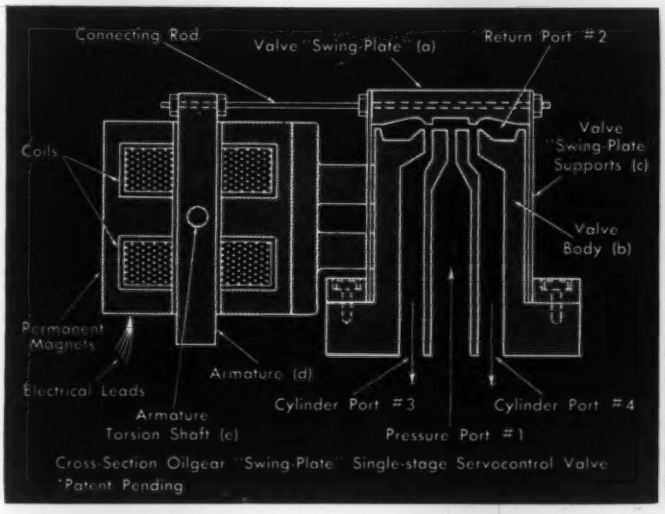
These programs include recently developed short-circuit and transient-stability programs, together with several older ones. Mr. Dillard also stated that additional programs now being developed by Westinghouse would be made available periodically as they were completed.

. . . Fluid Power news

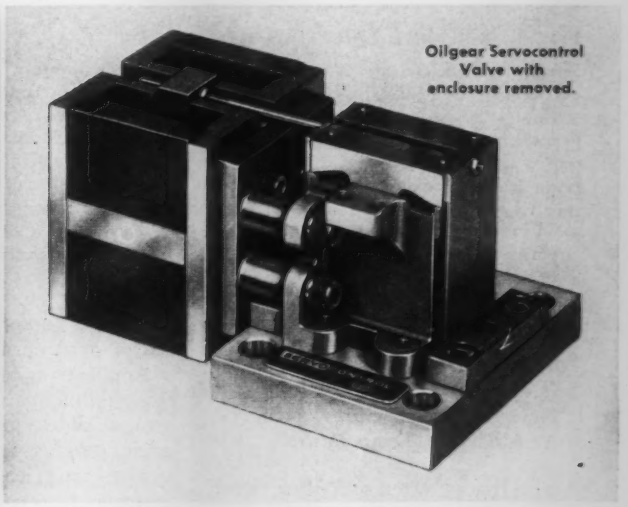
NEW INDUSTRIAL SERVO-CONTROL VALVES

New Oilgear Electrohydraulic Servocontrol Valves

SERVO VALVE DESIGN OBJECTIVES: 1: Greater control accuracy and resolution for rotation and straight-line drives. 2. For industrial applications, must be capable of controlling wide pressure and volume range with single-stage, fast response to a low input signal. 3. Eliminate conventional valve frictional problems between spools and cylinders. 4. Eliminate two-stage linkage and stability problems. 5. Eliminate first-stage pilot systems — supply pressure, centering devices, filters, and orifices required for pilot systems. 6. Provide a flow rate substantially linear to valve displacement, with stability in null position. 7. Eliminate or substantially reduce valve "dead-band," sticking, jamming, scoring. 8. Be "fail-safe." 9. Operate safely in hazardous locations.



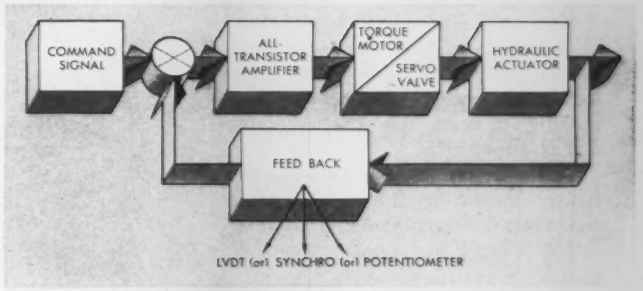
Cross-Section Oilgear "Swing-Plate" Single-stage Servocontrol Valve
*Patent Pending


Oilgear Servocontrol Valve with enclosure removed.

SOLUTION: **1.** A new concept of three and four-way single-stage electrohydraulic servo valve construction . . . only two moving parts in Oilgear's new "Swing-Plate" design. **2.** No metal-to-metal contact between "Swing-Plate" (a) and valve body (b) . . . frictionless for high sensitivity, fast response to minute signals — virtually eliminates sticking, scoring, jamming. **3.** Clearances and port seal sizes can be varied to suit application and fluid handled. **4.** Sharp, long rectangular chambers and lands linearize valve characteristics — flow rate essentially a linear function of valve displacement . . . supply high fluid power gain with minute "Swing-Plate" movement. **5.** Hardened stainless steel construction assures reliable operation well in excess of a hundred million cycles, even with non-lubricating fluids. **6.** No pilot system pressure, centering devices, orifices, or internal filters required. **7.** Spring-steel supports (c) respond instantly to low torque motor forces. **8.** As torque motor armature (d) pivots on torsion shaft (e), valve automatically centers in event of power failure for "fail-safe" operation. **9.** For operation above 500 psi, a compensating cap equalizes hydraulic forces to maintain selected clearances. **10.** No special modification required for use in hazardous locations. **11.** Valves — open or enclosed — can be gasket-mounted. Pipe tap subplates are available.

PERFORMANCE DATA: Flow Rate—4 gpm at 250 psi; 8 gpm at 1000 psi pressure drop across valve. Supply Pressures—to 3000 psi. Torque Motor; Mid Position Force—11 lb min.; 5 watts max. power demand; Stroke—±0.015 inches; Hysteresis—less than 3%; Differential Current—150 ma; Resistance per Coil—80 ohms. Other coil current and resistance values available. Net Weight—4¼ lb. Width: 4¾"; Height: 2¾"; Depth: 3".

Oilgear can supply all components for Fluid Power Servocontrol systems . . . all-transistor amplifiers, manual controls, preset controls, two-stage servo valves, variable displacement pumps, variable speed drives, motors and cylinders.



New Oilgear Servocontrol components applied to controls on Oilgear pumps and transmissions provide greater system accuracy and resolution. Functions easily attained with new Oilgear Servocontrol open and closed-loop systems are: 1. Precision, high-response speed control from zero to maximum rpm in either direction through remote control stations or switches. 2. Positive, high response, follow-up position control through remote command units. 3. Output motions or speeds with closed-loop systems will remain near constant with accuracies from 0.1% to 1.5%, and with resolution down to 0.05%.

For further information on these new valves and systems, call your Oilgear Application-Engineer. Or write, stating your specific requirements, directly to . . .

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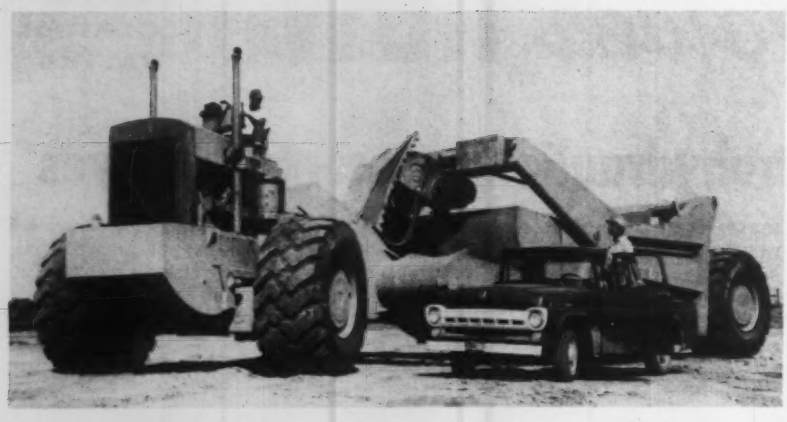


Sure-Footed Dirt Eater

Scraper called Goliath is said to be the world's biggest. The 70-ton capacity earthmover is the first shown by R. G. LeTourneau Inc., Longview, Tex., since the company left the earthmoving equipment business more than five years ago. Propulsion is by an "electrical wheel" system, which includes a powerful dc motor geared directly to the inner rim of every wheel. There are no wearing parts in the brake system, and "power proportioning" shifts power away from any wheel which begins to slip. The machine is 62 ft long and 14 ft wide.

Spray-On Teflon Forms Low-Friction Coating

New Dispersion Cures At Moderate Temperature

PORT HURON, MICH.—A slick, wear and corrosion-resistant surface of Teflon only 0.6 mil thick can now be sprayed on heat-sensitive materials like wood, rubber, and light metals. In other applications the coating protects the base against dirt and moisture.

Tetrafluroethylene resins (commonly known as TFE) withstand temperatures from −450 F to over +500 F, and are used as surface coatings because of their low friction coefficient, chemical inertness, and low moisture absorption. Suspension of TFE in a liquid carrier allows it to be applied with little or no heat, and adds the desirable characteristics of the carrier to those of TFE.

Two versions of the new coating have been developed: Emralon types 310 and 320. Type 310 is a dispersion of TFE in a phenolic binder which can be cured in one hour at 300 F as opposed to temperatures in excess of 700 F needed for the older sintering process for TFE. Type 320 is an air-drying version for substrates that will not tolerate even moderate temperature elevation, or for use where infrared or oven curing is impractical.

Applications for the coating range from industrial machinery to playground slides, military and hunting arms, parking meters, skis, window casings, and ice-cube trays. Manufacturer is Acheson Colloids Co., Port Huron, Mich., division of Acheson Industries Inc.

Digital Place Marker

Repeat settings to 1/100-turn accuracy are possible with this knob-shaft-counter package. The three-digit counter provides direct readings to ten revolutions of the shaft and is designed for use with multiturn potentiometers and capacitors. Manufacturer is Production Instruments Div., General Controls Co., Skokie, Ill.

Topics

Precious power for the U. S. Navy's submarine Barracuda comes from a $2½ million silver-zinc battery made by Yardney Electric Co. The firm is presently working on another battery, suitable for submarines, powerful enough to drive a railroad train from the East to the West Coast on one charge.

• • •

A somewhat smaller battery finds application in a different type of liquid environment: It is the power source for a cocktail stirrer that lights up. The stirrer is designed "for the fellow who prefers to mix Martinis in the dark."

• • •

Modern design compleats the angler by selling him fishing worms via a vending machine. Refrigerated worm vendors in Nyack, N. Y., dispense the live creatures for 50 cents a dozen; one machine sold 3000 night crawlers over a weekend. This machine is perhaps just a step toward the eventual vending-machine sale of freshly caught fish to luckless fishermen.

• • •

Long-distance color matching can be accomplished with a system for analyzing colors without looking at them, developed at the National Bureau of Standards. A recording spectrophotometer plots on graph paper the proportions of red, orange, yellow, green, blue, and violet that a sample of material, glass, etc., reflects or transmits. Feeding this information into a computer produces an expression of the resulting color curve in figures. These figures, fed into a computer again, provide an exact description of the original color. According to NBS, there are 10 million distinguishable colors.

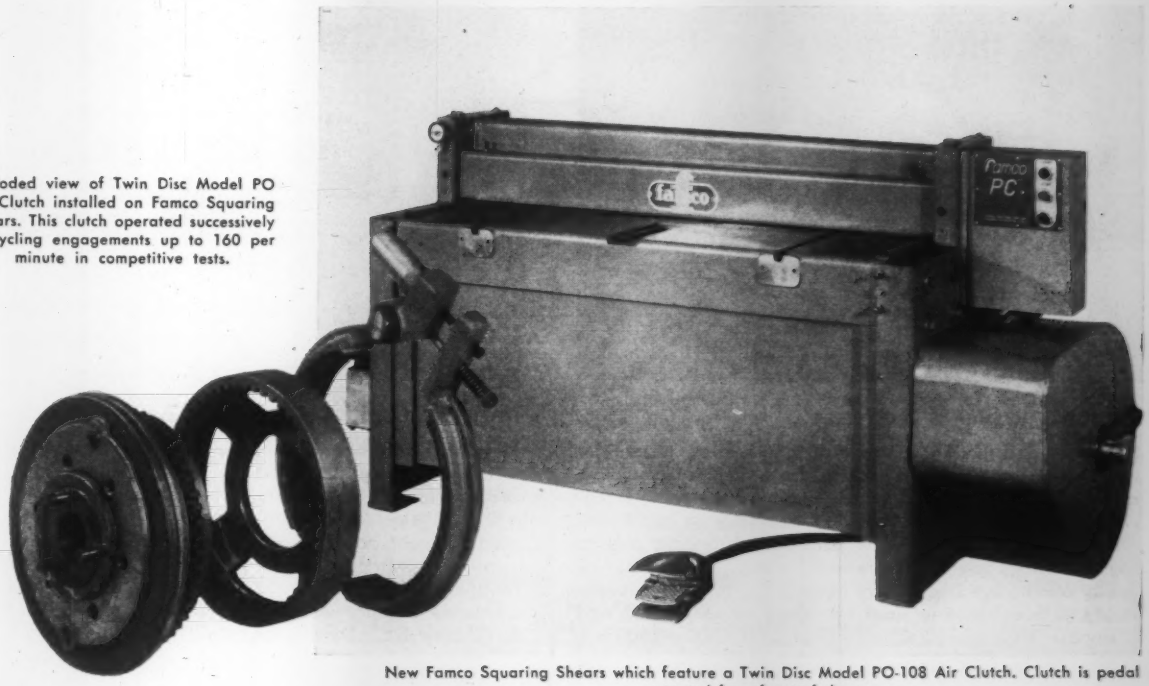
• • •

Two accessories Detroit doesn't offer automobile buyers are incorporated in Communist China's newest luxury car —a scented mahogany dashboard and silk carpeting. Like its capitalistic relatives, the car has eight cylinders and is air-conditioned.

• • •

Assistant's assistants' assistants: For each research engineer with a Ph.D degree, there are needed at least four engineers with master's degrees, 20 with bachelor's degrees, and 40 trained specialists. This is the conclusion reached by a commission composed of the regents of the University of California at Berkeley and the California State Board of Education. The state is helping to educate the "trained specialists" by opening free junior colleges which offer two-year courses for technicians. Industry is backing the idea by furnishing faculty members, lending equipment, and donating cash.

Exploded view of Twin Disc Model PO Air Clutch installed on Famco Squaring Shears. This clutch operated successively at cycling engagements up to 160 per minute in competitive tests.



New Famco Squaring Shears which feature a Twin Disc Model PO-108 Air Clutch. Clutch is pedal actuated from front of shears.

Air clutch wins over electric clutch in fast cycling test!

When Famco Machine Company, Kenosha, Wisconsin, tested machine components for their new line of "PC" Series Square Shears they wanted a fast-acting dependable clutch.

Under controlled conditions, Famco engineers tested an electric single face dry clutch and a Twin Disc single plate 8" Model PO Air Clutch. The shear operates at 300 S. P. M., completing one cycle in 0.20 seconds. In cycling up to 160 single strokes per minute, only the Model PO Air Clutch could provide the fast action required.

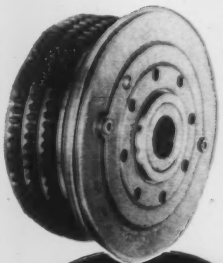
Today, the Twin Disc Model PO Air Clutch is standard equipment on Famco's new shears for 16, 18 and 20 gauge mild steel in widths of 36, 42, 52 and 72 inches.

Besides fast action, these new Twin Disc Air Clutches offer such other profitable advantages as:

- New design permits highest capacity at up to 40 per cent less cost than comparable remote controlled air clutches.
- Available in sizes 8, 10 and 11⅜ inches . . . in triple-plate, double-plate and single-plate construction . . . up to 3480 lb.-ft. in torque capacity.
- Exclusive cartridge-type diaphragm of long-lasting neoprene reinforced with nylon . . . eliminates leakage and provides long life.
- Constant torque capacity . . . no adjustment, self-compensating for wear.
- Compact and rugged . . . with clutch mass properly distributed relative to friction area, providing long life on high energy loads.
- Suitable for air systems up to 130 pounds per square inch.

These three new sizes extend the time-tested, job-proved line of PO Air Clutches from 8 to 36 inches . . . in torque capacities to 166,800 lb.-ft. . . . to meet the widest variety of industrial applications.

Test a Twin Disc Model PO Air Clutch in your laboratory . . . and include it in your next design. See for yourself how this type clutch lends itself to convenient, economical remote control. Write Twin Disc Clutch Company, Racine, Wisconsin, for complete details.



TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES

TWIN DISC
Clutches

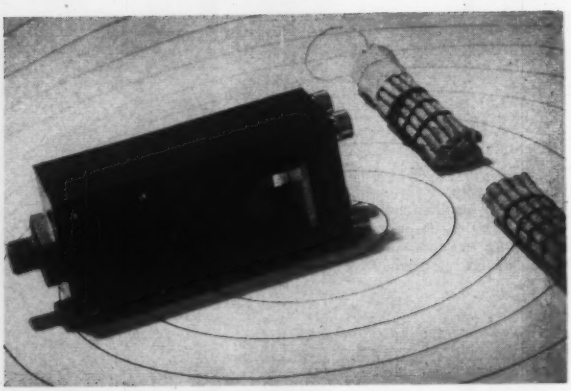
TWIN DISC CLUTCH COMPANY, Racine, Wisconsin • HYDRAULIC DIVISION, Rockford, Illinois

BRANCHES OR SALES ENGINEERING OFFICES: CLEVELAND • DALLAS • LOS ANGELES • NEWARK • NEW ORLEANS

Circle 408 on Page 19

Microwave Leak Detector

Hot spots and leakage areas around antennas, transmitter tubes, and other radar plumbing are easily surveyed with a small, battery-powered search meter. The new unit provides a continuous direct reading both in mw per sq cm and in db relative to 10 mw per sq cm (standard physiological energy-tolerance reference level). Developed by Sperry Microwave Div., Sperry Rand Corp., the meter is produced in three types to cover frequency ranges in S, C, and X bands: 2700—3300, 5200—5900, and 8500—9600 mc.



No-Short Cuts

Propellant-driven cable cutter with ceramic blade and anvil provides quick, positive circuit breaks without creating short circuits between conductors. The cutter can cleanly sever a 2½-in. steel cable within 10 to 12 milliseconds. It is used to great advantage in missiles and rockets, where it turns off electric power at precisely the right instant by chopping cables—a drastic but effective way to get low-resistance circuitry void of switches and relays. Beckman & Whitely Inc., San Carlos, Calif., developed the cutter.

Industry Is Invited To Develop Atom at Government Expense

AEC Looks for New Radioisotope Uses

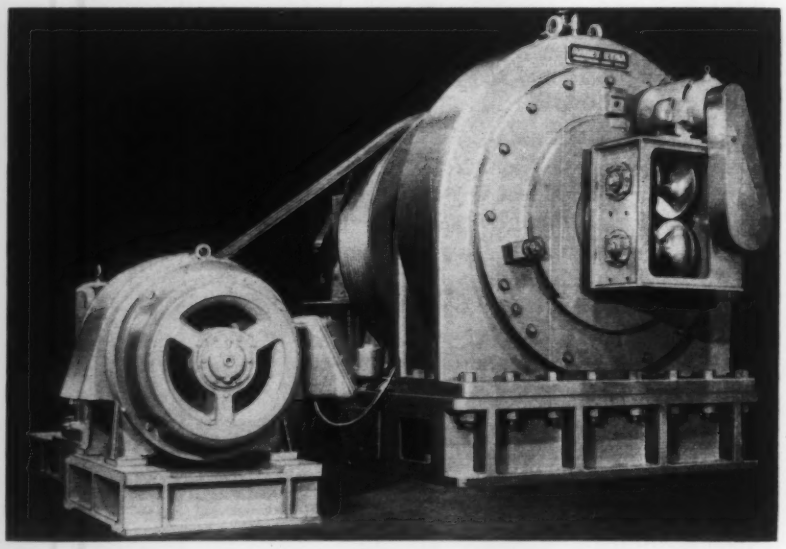
WASHINGTON—Industry has been invited to take part in a joint effort to develop new, everyday radioisotope uses important to the national economy. Funds to support the effort are to be provided by the Atomic Energy Commission.

According to AEC, "Reliance must be placed upon engineers and technicians, familiar with their own industrial problems, to propose new ways for applying radioisotopes." The AEC will evalute individual proposals on the basis of a number of factors, including potential contribution, advancement of technology, and originality of the proposed development.

Development proposals should include details such as:

- Clear statement of the problem and existing state-of-the art.
- Why radioisotopes are used or recommended.
- Competitive methods and expected economic advantage of radioisotopes.
- Scope of the proposed use in terms of number of industries and number of units involved.
- Details of technique, equipment, and facilities to be used.

Additional information on submitting contract proposals may be obtained from the Director, Office of Industrial Development, U. S. Atomic Energy Commission, Washington 25, D. C.



Pipe This

Production of 8-in. standard Saran-lined pipe is possible for the first time on the world's largest swaging machine. Pipe lengths pass completely through the swager spindle, and OD is reduced ½ in. over a Saran liner for the entire pipe length. Developed by Abbey Etna Co., Perrysburg, Ohio, the big machine has a 16-in. die length and swages at the rate of 15 ft per min by delivering 2000 hammer blows per min. The ac drive motor, designed by Reliance Electric & Engineering Co., develops 150 hp.

ND FACTS

TINY SIZE . . .

TREMENDOUS IMPORTANCE!

New Departure has many years of experience in the manufacture of ball bearings to the finest ultra-precision tolerances. And . . . New Departure uses the most advanced equipment for research, development and production in making a full range of bearings of precision instrument classification. A new catalog, including miniature sizes, plus additional information helpful to you in design problems sent on request. Write New Departure, Division of General Motors, Bristol, Conn.

ASK FOR CATALOG P.I.B.

FULL SIZE	BORE B		DIAMETER D		WIDTH W		BALLS		CORNER RADIUS r (To Clear)
	FRACTION	DECIMAL	FRACTION	DECIMAL	FRACTION	DECIMAL	NO.	DIAMETER	
	3/64	.0469	5/32	.1562	1/16	.0625	5	1/32	.005
		.0550	3/16	.1875	5/64	.0781	6	1 mm	.005
	5/64					.0937	5	1/16	.006
	3/32					25	8	.025	005
	3/32						6	1/16	
	1/8							1 m	
	1/8								
	5/32	.15							
	3/16	.1875							.005
	3/16	.1875	3/8					mm	.006
	1/4	.2500	3/8	.3750					.006
	1/4	.2500	1/2	.5000	1/8	.1250	*12	*1 mm	.006

GM FORWARD FROM FIFTY

NEW DEPARTURE

DIVISION OF GENERAL MOTORS, BRISTOL, CONN.

NOTHING ROLLS LIKE A BALL

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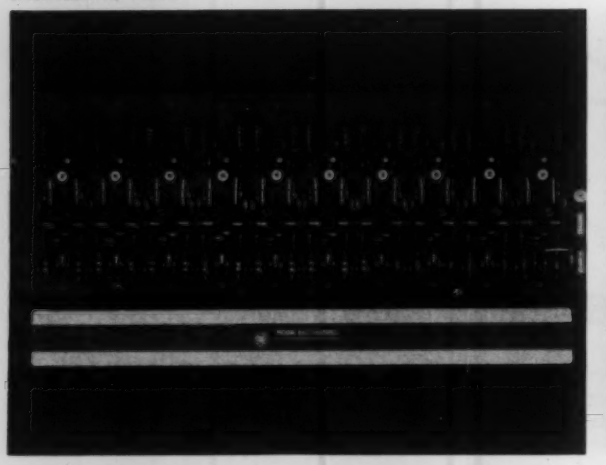
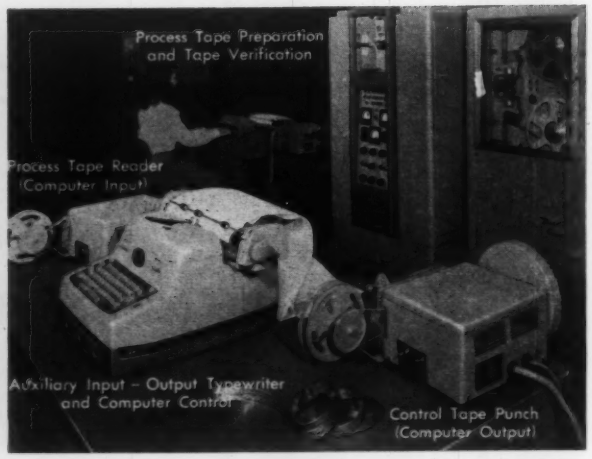


Electronic Commutator for High-Speed Pickup

A new solid-state, high-speed electronic commutator handles up to 1000 channels of information at rates of 100,000 samples per sec. It can be used with ac or dc signals in voltage-to-digital converter applications, or can commutate the output of a digital-to-voltage converter into a number of channels. If a holding circuit is required for the voltage outputs, solid-state sample and hold circuits are available. Developed by Packard-Bell Electronics Corp., the device is used to advantage with solid state conversion systems. This combination provides a small, low-powered unit especially suited for aircraft applications.

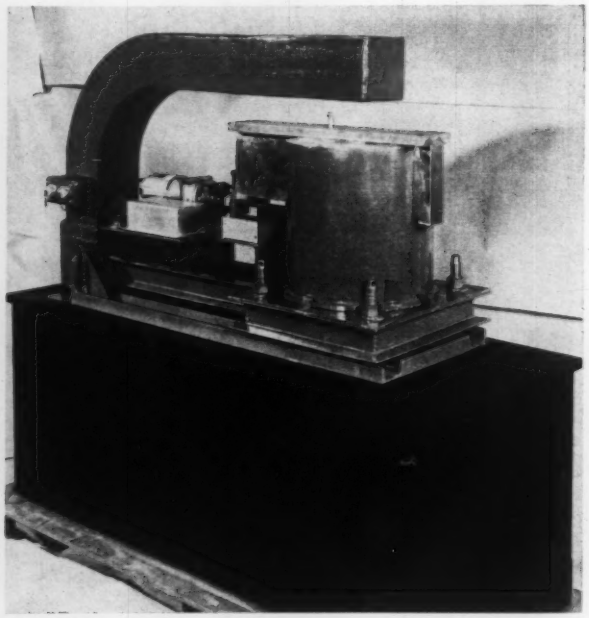

Process Tape Preparation and Tape Verification
Process Tape Reader (Computer Input)
Auxiliary Input – Output Typewriter and Computer Control
Control Tape Punch (Computer Output)

Tape Punch Is Computer Controlled

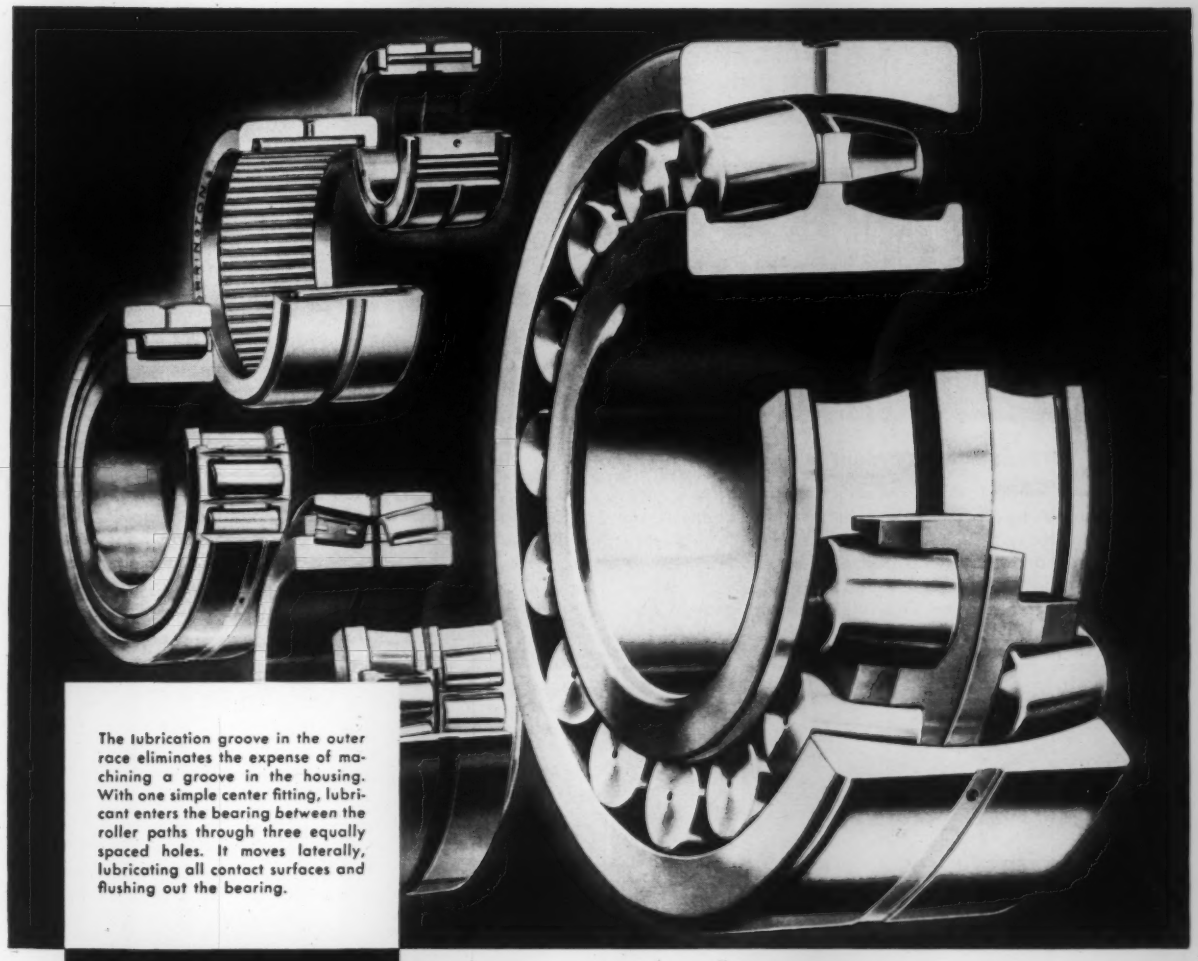
Control tapes for two and three-dimensional contour machining are automatically prepared in a new tape preparation system. Developed by Bendix Industrial Controls Section Bendix Aviation Corp., the system uses a special process sheet, a Flexowriter with tape punch, and a Bendix G-15D digital computer. The process sheet is used to list coordinate dimensions of the part being machined, desired cutting sequence, machine feed rates, cutter diameter, tolerance, and other pertinent information. This information is reduced to tape form by the Flexowriter for input to the computer, and the computer prepares the final control tape.

Atoms for Measuring

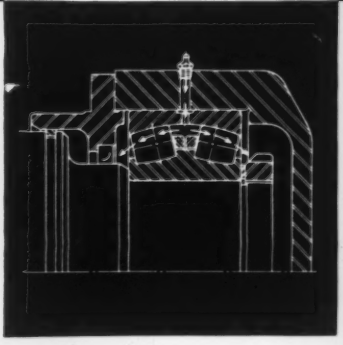
Two-beam atom gage automatically measures the contents of sealed, opaque containers. Lower beam checks for underfilling—upper beam for overfilling. System can be set to reject improperly filled containers. Produced by Nuclear Corp. of America, the compact equipment can gage up to 1000 containers per minute as its radioisotopes "peer" into cans, bottles, cartons, carboys, or drums.



Noncontacting atom gage continuously measures thickness and density of a wide variety of materials. Cobalt 60 radiation source, housed in heavily shielded circular container (center), emits gamma rays through material to a scintillation counter mounted in the C-frame directly above it. Manufactured by Nuclear Systems, a division of the Budd Co., the gage has a high rate of response.



The lubrication groove in the outer race eliminates the expense of machining a groove in the housing. With one simple center fitting, lubricant enters the bearing *between* the roller paths through three equally spaced holes. It moves laterally, lubricating all contact surfaces and flushing out the bearing.



A time-proved lubricating method now available on Torrington Spherical Roller Bearings

The circumferential groove in the outer race has met the test of experience in many Torrington Bearings, including Heavy Duty Needle Bearings, Aircraft Type Needle Bearings, Tapered and Radial Roller Bearings. Now the circumferential lubrication groove is available in Torrington Spherical Roller Bearings.

This design feature makes it possible to introduce lubricant *between* the roller paths without the expense of machining a groove in the housing. This groove is proportioned to provide generous lubricant flow capacity. Lubricant moves through the roller paths, flushing used lubricant and contaminants away from bearing contact surfaces.

Torrington Spherical Roller Bearings in many sizes may be ordered with this groove as desired at no additional cost. For further information, see your Torrington representative or write: **The Torrington Company, South Bend 21, Ind.—and Torrington, Conn.**

TORRINGTON BEARINGS

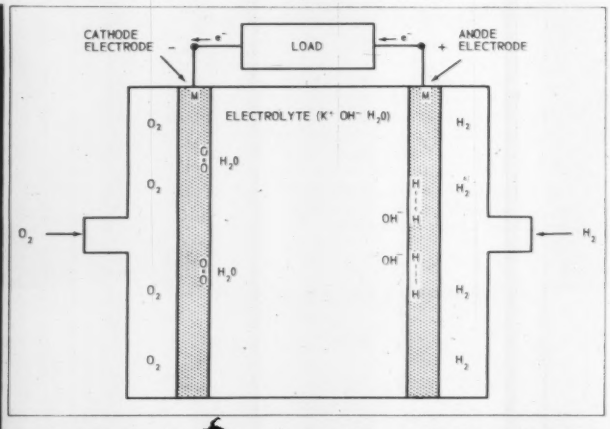
District Offices and Distributors in Principal Cities of United States and Canada

SPHERICAL ROLLER • TAPERED ROLLER • CYLINDRICAL ROLLER • NEEDLE • BALL • NEEDLE ROLLERS • THRUST

Circle 410 on Page 19

Field and Stream Landing Gear

Water, snow, mud, ice, or normal runway surfaces are taken in stride by a versatile new landing gear being tested by the Navy. Developed by All American Engineering Co., the gear resembles a pair of short, wide skis with cutouts for the airplane's wheels. Pictured above, a deHaviland Otter equipped with the universal gear makes a beach-to-water takeoff. A successful water-to-beach landing was the next step. Commercial applications for the gear include possible use on various light planes to permit shuttle service from outlying municipal airports to rivers and lakes in central metropolitan areas. Surplus prop-driven transports may gain added service.



Gaseous fuel cell powers two 15-watt bulbs to illuminate itself and Allis-Chalmers research scientist. Fuel cell, with possible efficiency of 90 per cent, promises 50 per cent more efficient operation than best present-day diesel-electric sets. The 24-volt cell shown is one in a series of laboratory models being constructed to obtain experimental data which will be incorporated into fuel-cell designs for tests on a greater scale. Diagram shows load being energized by electrons released by reaction of hydrogen and oxygen.

Fuel Cell Mixes Gases, Yields Electrical Energy

Escapes Heat-Cycle Energy Losses

MILWAUKEE—Operating principles of a fuel cell, a device that converts chemical energy of incoming gases directly into electrical energy, were revealed recently by the Allis-Chalmers Co. Describing their new experimental model, the company pointed out that the fuel cell has a possible efficiency of 90 per cent because it escapes heat-cycle energy losses.

In the fuel cell, hydrogen gas is adsorbed onto the catalyst at the anode. Activated there, it reacts with an ion in the electrolyte, releasing an electron to the external circuit. At the cathode, oxygen gas is simultaneously adsorbed. Activated, it reacts with the electron from the external circuit and with the electrolyte to reform the ion that disappeared at the anode.

In the over-all reaction, hydrogen and oxygen disappear to yield water and the flow of electrons through the external wiring circuit. Output voltage is characteristic of the chemical reaction.

The industrial possibilities of a commercial fuel cell are numerous.

Direct current for adjustable speed motors, along with extra available power for peak loads, are two considerations. As a source of stored energy, it could be used in defense projects, in marine and hospital service, and as a remote-area power source. By using off-peak generating facilities to produce hydrogen and oxygen, power companies could store and transfer the gases for use anywhere a fuel-cell arrangement was established.

Find Uranium Alloys Are Superconductors

Old Theory Refuted By New Compounds

PITTSBURGH—Uranium has yielded a new "family" of superconductors. The new intermetallic compounds, each an alloy of uranium and one other metal, were discovered by Dr. B. S. Chandrasekhar and Dr. J. K. Hulm, both of Westinghouse Research Laboratories.

The alloys showed surprising temperature-resistance characteristics. Contrary to the behavior of all known alloys, their electrical resistance increased as the temperature was decreased all the way down to one or two degrees above absolute zero. Here, they suddenly became superconductors.

"Superconductivity is among the most startling phenomena in all physical science," Dr. Hulm said. It occurs in various metals and alloys at very low temperatures. For reasons that are not well understood, the electrical resistance of these materials suddenly drops to about 10^{-15} of normal value. Electric currents then flow undiminished and apparently forever.

"Undiscovered superconductors were found among the intermetallic compounds containing cobalt, manganese, and iron," Dr. Hulm reported. "Of special interest is the fact that two of them are the first superconducting compounds ever known to contain manganese and iron. Heretofore, the presence of these two elements has been regarded as 'death' to the superconducting state. That theory is no longer acceptable. Indeed, these new superconductors . . . may be among the most useful in superconductor research."

DRAFTING TRENDS

To prove how a POST *Tuf-Tex print stands up under wear and tear, we put one through the washing and drying cycle of this automatic laundry equipment. The print did not tear, lines remained crisp and black, the intermediate print gave excellent reproduction.*

New Mylar base for intermediate prints offers many advantages

Big news for firms looking for superior reproduction materials has been the recent introduction of Mylar base intermediate films (Mylar is DuPont's registered trademark).

Here is a polyester film with remarkable dimensional stability . . . and so tough it is impossible to tear with your bare hands. POST took this durable, high strength film and did some exciting things with it. They developed a special solution to coat the film as a reproduction master that produces intense, blackline print images easily and conveniently via direct positive printmaking equipment.

They named the new product, Vapo Tuf-Tex (POST 208PE).

Merely run POST 208PE through any ammonia process whiteprinter . . . quickly you have a virtually indestructible blackline intermediate. Just one trip through the printer does the job, no extra steps, no negatives, no muss. And, print image is just as crisp and sharp as can be . . . thanks to specially developed formulations used in POST's famous, exclusive "Controlled Coating" techniques.

Takes a beating—asks for more

Best of all, a Tuf-Tex print really stands up under the punishment of frequent handling. Make extensive modifications . . . send it through the printer repeatedly . . . take it in and out of file frequently . . . make alterations . . . and still the print retains its strength and excellent printback characteristics.

Along with the dense blackline image on the glossy side, Tuf-Tex prints have an ideal matte surface on the other side that permits clean, crisp pencil or ink lines for changes and corrections. It's like drawing on a quality cloth. Available in base material thickness of either .003 or .005 inches, POST 208PE makes drawing easier and reproduction surer. Print images can be removed conveniently with a special single-stage eradicator (POST 240).

This fresh development in reproduction materials opens up new vistas well worth investigating for many different drafting applications.

For information on 208PE Tuf-Tex, see your local POST *blueprinter, or write to Frederick Post Company, 3652 N. Avondale, Chicago 18, Illinois.*

POST

SENSITIZED PAPERS & CLOTHS • TRACING & DRAWING MEDIUMS • DRAWING INSTRUMENTS & SLIDE RULES
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Hypoid Bevel...
Zerol Bevel.....*
Straight Bevel...
Coniflex Bevel...*
Flywheel Ring Gears .....
Straight Spur.....
Spur & Helical...
Spline Shafts.....
Straight & Spiral Angular Bevel....
Assemblies.....

write ➧
(on your letterhead)

IS THE ANSWER TO YOUR GEAR PROBLEM IN THIS NEW 44-PAGE CATALOG?

The 10 gear types in which we specialize are comprehensively covered together with "vital statistics" on our 44 years of gear specialization. Our gear engineers are available for consultation.

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*Reg. U.S. Pat. Off.

Reader Information Service

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USE A YELLOW CARD *for More Information . . .*

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EDITORIAL CLIPSHEETS—So you won't have to "clip" this issue, we'll be glad to send a personal copy of any article as long as the supply lasts. Just fill in the page number and title of article in the place provided on the Yellow Card.

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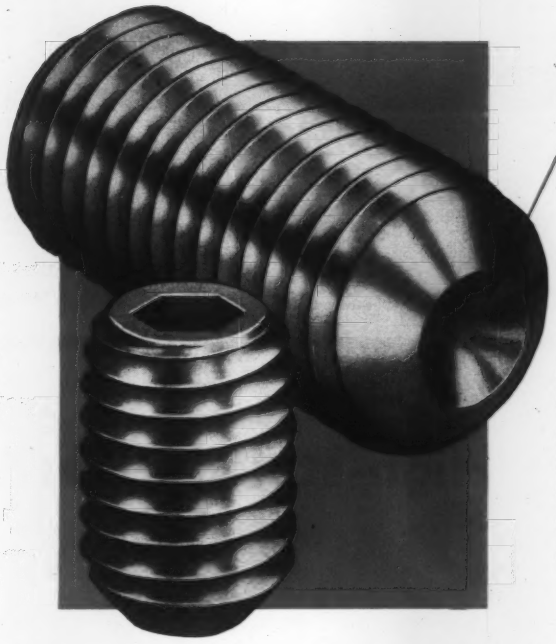


ALLENPOINT will give you a bulldog grip at no premium in price!

Allen's scientific redesign of the cup diameter on set screws gives greatly increased resistance to *withdrawal* torque. You can count on Allenpoint Set Screws to stay tighter longer, under heavy strain and vibrations. This dependable premium performance of Allenpoints is yours to use without increasing the cost of manufacturing your products.

Uniform Class 3A Threads

Allenpoints' smooth, uniform threads prevent off-lead conditions like Fig. 1. With Allenpoints, you have full, even contact between the engaging flanks of the threaded members (Fig. 2) —and a tight friction lock over the entire length of the Allenpoint Set Screw.

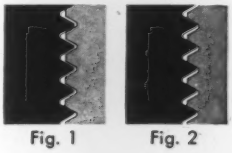


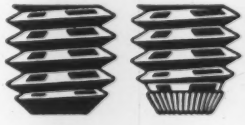
Fig. 1 Fig. 2

Strong, clean, deep sockets allow full wrenching leverage

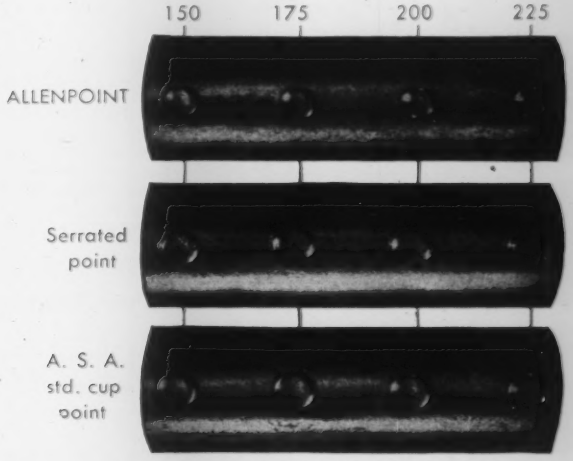
Sockets of Allenpoint Set Screws are cold forged to produce a deeper, smoother socket. No broach chips to interfere with proper seating of the key. This "pressur-forming" preserves the long steel fibers throughout the length of the screw—stronger walls allow maximum tightening torque.

One more full thread on ALLENPOINTS!

Allenpoint Set Screws have one more full thread than serrated point set screws. That means more holding power—especially important when you're using short lengths.



ALLENPOINT's performance compared for you



These actual-size, unretouched photographs show the cup pattern made by Allenpoints, serrated points, and A.S.A. standard cup point set screws in a 3/4" steel shaft. At each degree of tightening force, Allenpoints make a full circle pattern, penetrating deeper for greater holding power.

We'll be glad to send you more information and samples of Allenpoint Set Screws and other Allen Socket Screw products.

Stocked and sold by leading industrial distributors everywhere

ALLEN MANUFACTURING COMPANY
Hartford 1, Connecticut, U. S. A.

ALLEN HEAD HEX-SOCKET SCREWS

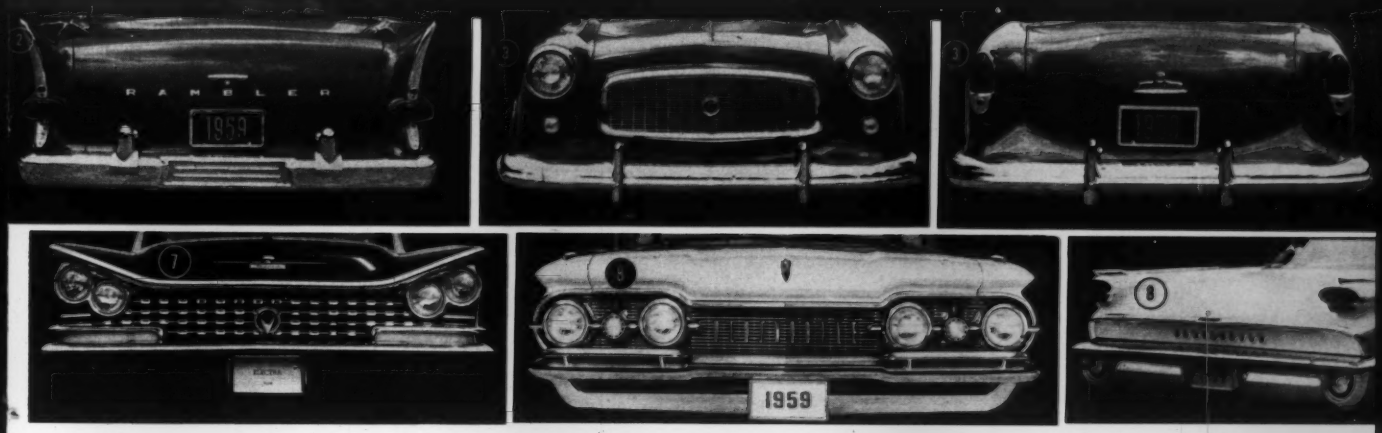
High-styled power:

RECAP '58: Sales and size of automobiles showed signs of being inversely proportional in 1958. While sales of small-sized imports have sneaked upward gradually for the past several years, they jumped to a new high this year (about 7 per cent of new registrations). Why did this occur during one of the poorest post-war years in the American car market? The answer is complicated.

Two years ago, Detroit automakers dismissed the small-car "spree" as a fad. They had plenty of market evidence—gathered by pollsters, market analysts, and auto executives—to back up their view, and they still have. Low-price, stripped-down American cars don't sell; the public has consistently picked the top of the line. People want chrome, power, size, and gadgets.

But as strong as this evidence seems to be, rising small-car sales indicate that something is amiss, and this has given rise to some strange and interesting theories concerning basic psychology, buyer psychology, sales psychology, big cars, small cars, economics, and even engineering:

• **Economy (U. S.):** People are just finishing, or relaxing, from big-car



the '59s

1. Ambassador
2. Rambler
3. Rambler American
4. Chevrolet
5. Pontiac
6. Cadillac
7. Buick
8. Oldsmobile

payments they assumed during the boom sales years of 1955-56.

• **Economy (cars):** An increasing number of people want economical transportation at a reasonable initial cost, plus a car that isn't completely outdated, stylewise, at the end of one year.

• **Psychology-Sociology:** The vice president of one of Detroit's Big Three took a stand on this issue: "The small car buyer is generally college educated. If he is economy-minded, reluctant, or unable to buy a new car, and unwilling for reasons of prestige to buy a used car, the small imported car gives him an out. Both he and the small car buyer who is not seriously concerned about economy are motivated by the fact that a small car is considered smart in his own circle. The small-car spree, in other words, is a form of keeping up with the Joneses, only with reverse English."

Other authoritative observers of the social scene say that cars are no longer the symbol of prestige in the average American community.

• **Craftsmanship:** Small cars have been called a product of "better materials and workmanship. They don't rust out in a couple of years, and an engine tuneup doesn't require a day, or cost a day's pay."

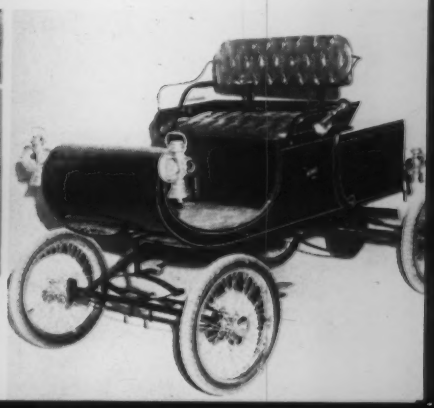
Whatever the reason, there are good signs that Detroit's Big Three will build their version of a small car in time for the 1960 market.

Meanwhile, the '59 models are on the road, and automotive engineers have again refined and improved their product within the limits of budget and styling. Taken one year at a time, design improvements may seem minor, but the average 1959 car will be driven 123,000 miles, compared with the 90,000-mile life of 1949 models. It will get about 43 ton-miles per gallon, compared to 25 ton-miles in 1930; and the '59 car will have been road tested for 50,000 miles prior to appearing in showrooms, compared to the standard road test of 25,000 miles 10 years ago.

On the following pages, a run-down of the 1959 automobiles begins with cars from General Motors and American Motors. New engineering features are emphasized. Ford, Chrysler, and Studebaker-Packard cars will appear in a subsequent issue.

The Mavericks:

Defying all the usual American auto standards in styling, size, and power, Volkswagen, theoretically, shouldn't stand a chance against U. S. competition. The car's ever-growing and vocally-active following understandably puzzles many experienced automobile executives. While VW is at least a product of the mid-20th century, the amazing 1958 success of a 2/3-scale 1901 Oldsmobile, minus reverse gear, is completely out of the realm of auto realism. Called Rollsmobile, the revived buggy is aptly advertised as "the car with the backward look."



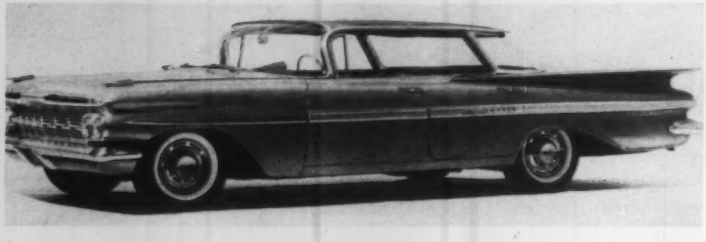
Cadillac

ENGINE: Displacement has been increased from 365 to 390 cu in. Stroke is lengthened 0.25 in. and compression ratio increased to 10.5 to 1, up from 10.25 to 1. Power rating is 325 hp in the standard model, 345 hp in the Eldorado. This compared to 310 and 335 hp last year.

BODY-FRAME: Bodies have been lowered as much as 5.5 in.

SUSPENSION: Captive-Freon shock absorbers are new for '59.

ACCESSORIES: Optional Cruise Control permits constant-speed driving with no pressure on the accelerator.



Buick

Three series—Electra (top of the line), Invicta, and LeSabre—replace the five-series lineup of last year.

ENGINE: Powerplant redesign puts a 401-cu in. engine in the Electra and Invicta series, replacing the 365-cu in. engine in comparable 1958 models. Rated power has been boosted from 300 to 325 hp. LeSabre has a 364-cu in. engine rated at 250 hp, same as in last year's Special.

BODY-FRAME: New K-type frame with boxed-in side rails replaces last year's I-beam, X-member construction.

BRAKES: Both front and rear drums are finned for better cooling. Last year only front drums had fin-cooling.

ACCESSORIES: Positive Traction differential is offered as optional equipment on all models.

Oldsmobile

ENGINE: Displacement of the Super 88 and 98 engine has been increased from 371 to 394 cu in. Power is up from 305 to 315 hp. The 270-hp 88 engine remains the same as last year, with minor refinements to improve fuel economy.

BODY-FRAME: Frame is 9 in. wider and 10 in. longer than last year, with an increase of 10.2 in. and 6.3 in. in over-all car length of the 88 and 98 series respectively. All bodies are 2.3 in. wider and up to 3.2 in. lower.

ACCESSORIES: Power steering utilizes a new rotary-valve unit that decreases steering effort and reduces size, weight, and number of parts in the system.

Pontiac

ENGINE: A powerplant designed for economy that uses regular fuel is featured as one of two basic engines offered in '59 models. While both engines displace 389 cu in., up from 370 last year, the economy package has a compression ratio of 8.6 to 1 and produces 215 hp. Top engine in the line has a 10.5 to 1 compression ratio and rates 315 hp.

BODY-FRAME: Wheel tread has been increased nearly 5 in. over '58 models to improve stability. Bodies are 9 in. longer, 3 in. wider, and up to 3 in. lower.

ACCESSORIES: Power steering incorporates new rotary-valve assembly used on other GM cars. Antispin differential is optional on all models.

Chevrolet

ENGINE: Refinements on the 235-cu in. six-cylinder engine are featured: Camshaft has been redesigned, and carburetor metering changed to improve economy at normal driving speeds.

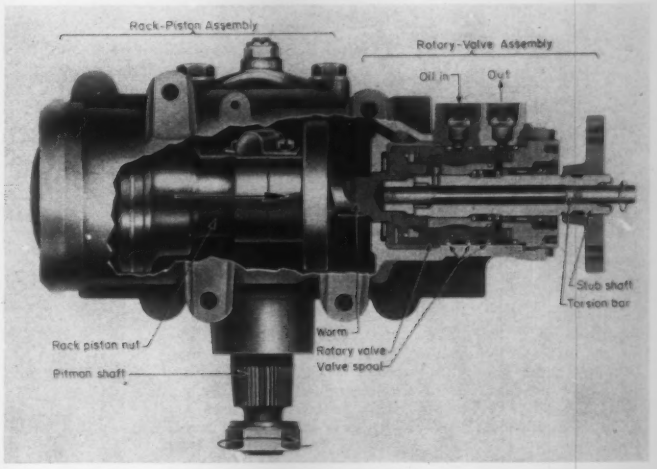
BODY-FRAME: Sedans have been reduced in height 1 in., sports models 2 in., and front-seat width in all models shows an increase of 5 in. Over-all glass area is up to 50 per cent greater than last year, with the addition of 1189.5 sq in. of glass in some sedan models. The El Camino, a high-styled pickup truck paralleling Ford's Ranchero, is new for 1959.

SUSPENSION: Rear coil-spring system has been refined to improve ride and stability.

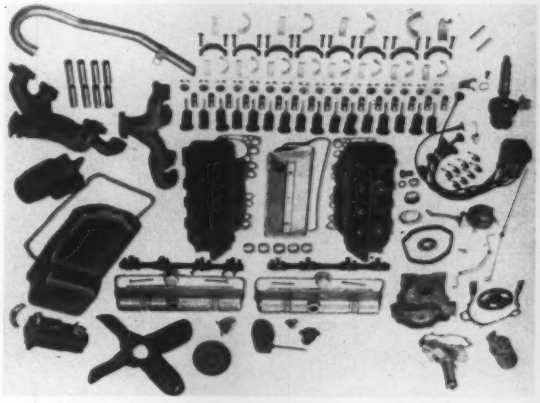
ELECTRICAL SYSTEM: Battery-charging circuit is separate from generator-to-load circuit

GM cross section: More power, easier steering, better riding . . .

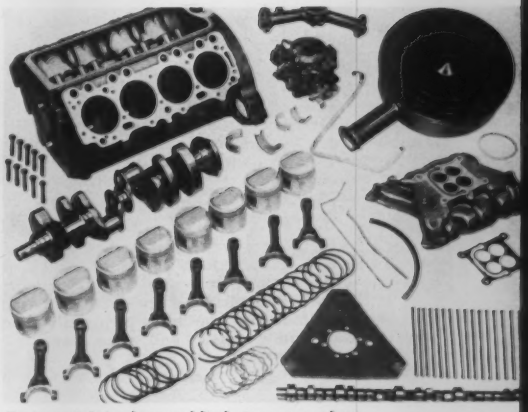
Precision and ease of power steering are enhanced on most GM cars with a new rotary-valve steering-gear assembly. On the '59 Buick, initial hydraulic response is obtained with 0.3-deg movement of the steering wheel. This compares to a 6.7-deg threshold last year. Normal driving effort now requires from 1 to 2.25 lb force on the steering wheel; a 2 to 4-lb force was required on '58 models. The new steering system is also self-adjusting: Wear on gear teeth is compensated by a washer and spring assembly inserted in the pitman shaft to keep gears in perfect contact. In operation, the new rotary-valve is essentially a servo follow-up unit: When the steering wheel is turned, deflection of the torsion bar allows the stub shaft and valve spool to rotate with the steering wheel. This changes port alignment between valve spool and valve body, directing the flow of oil to the proper side of the rack-piston nut to assist the driver. The signal is cancelled out when the front wheels reach the desired angle.



Buick engine: 1958 vs. 1959. Increasing the bore 0.625 in. and lengthening stroke 0.240 in. involves a major design change. Net result is more power at lower speeds. Maximum torque developed by the new engine is 445 lb-ft at 2800 rpm compared to last year's 400 lb-ft at 3200 rpm.



Parts interchangeable between engines



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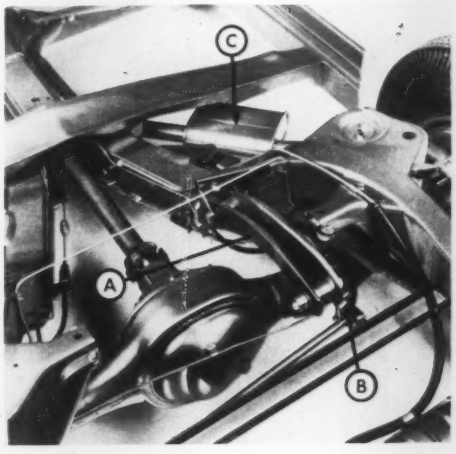
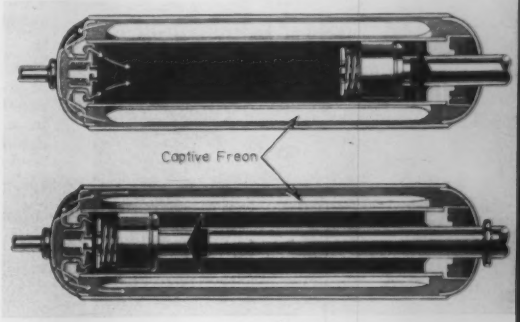
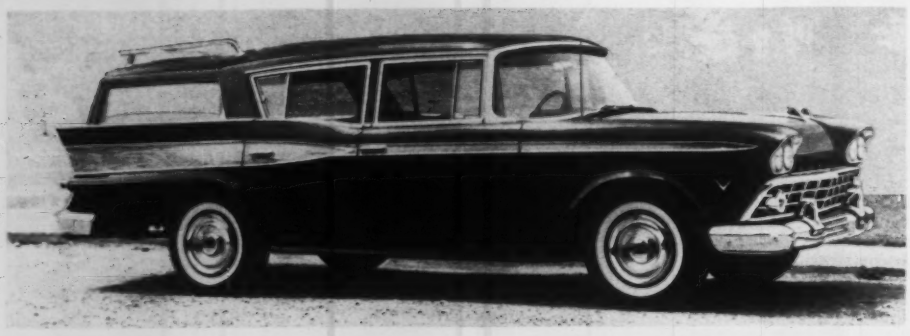


Rear suspension refinement on '59 Chevrolets includes two specialized members: 1. Curved overriding member *A*, pivot anchored at its ends to the frame and to the banjo housing of the axle. 2. Lateral control bar, *B*, connecting the right side of the axle housing to the left side of the frame. In operation—when the rear wheel hits a bump—the new suspension geometry permits the unsprung mass to oscillate with minimum lateral reaction to the frame. In previous design, full effectiveness of upper control arms was compromised because they had to control both vertical and lateral movements. Also new on '59 models are sound-softening resonators, *C*, between muffler and tail pipe on V-8's with dual exhausts.



Freon-12 in a plastic sleeve replaces air in Cadillac shock absorbers. Since no mixing of air and oil can occur, action of the shock absorber is relatively constant and ride characteristics are improved.

Comfort and simplicity are featured in new AM accessories . . .



Rambler

Ambassador

Rambler American

ENGINES: Powerplant specifications remain the same as last year: Rambler American is powered by a 90-hp L-head six; the Rambler series comes with either a 127-hp version of the American engine or a 215-hp V-8 (Rebel) engine. The Ambassador uses a 270-hp V-8 engine. The 127-hp six features a new carburetor which is said to improve fuel economy by 1.5 mpg. Exhaust systems on all engines have been redesigned for longer life: Mufflers have an aluminized coating on internal tubes, baffles, and end plates. Tail pipes are 40 per cent thicker and are also aluminized.

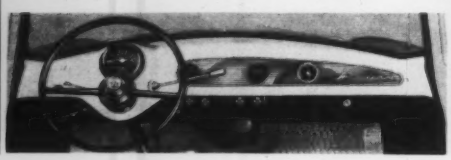
BODY-FRAME: Over-all dimensions are largely unchanged. A 100-in. wheelbase station wagon has been added to the Rambler American line. Front reclining seats, optional on most models, are individually adjustable—front cushion is divided and the two seats are mounted on separate tracks. New front-seat headrests are optionally available for added comfort in the reclined position and as a safety feature in preventing neck injuries in event of rear-end collisions.

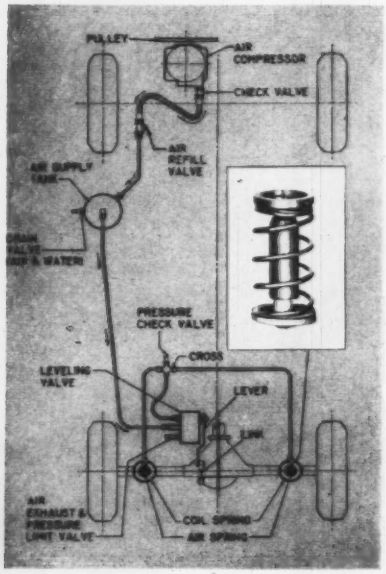
ACCESSORIES: Self-adjusting brakes are available on all models. A standard accessory which is not new this year, but which is still unique among new cars, is the owner's handbook provided with Rambler and American models. The book pictorially describes how to make minor repairs and adjustments.

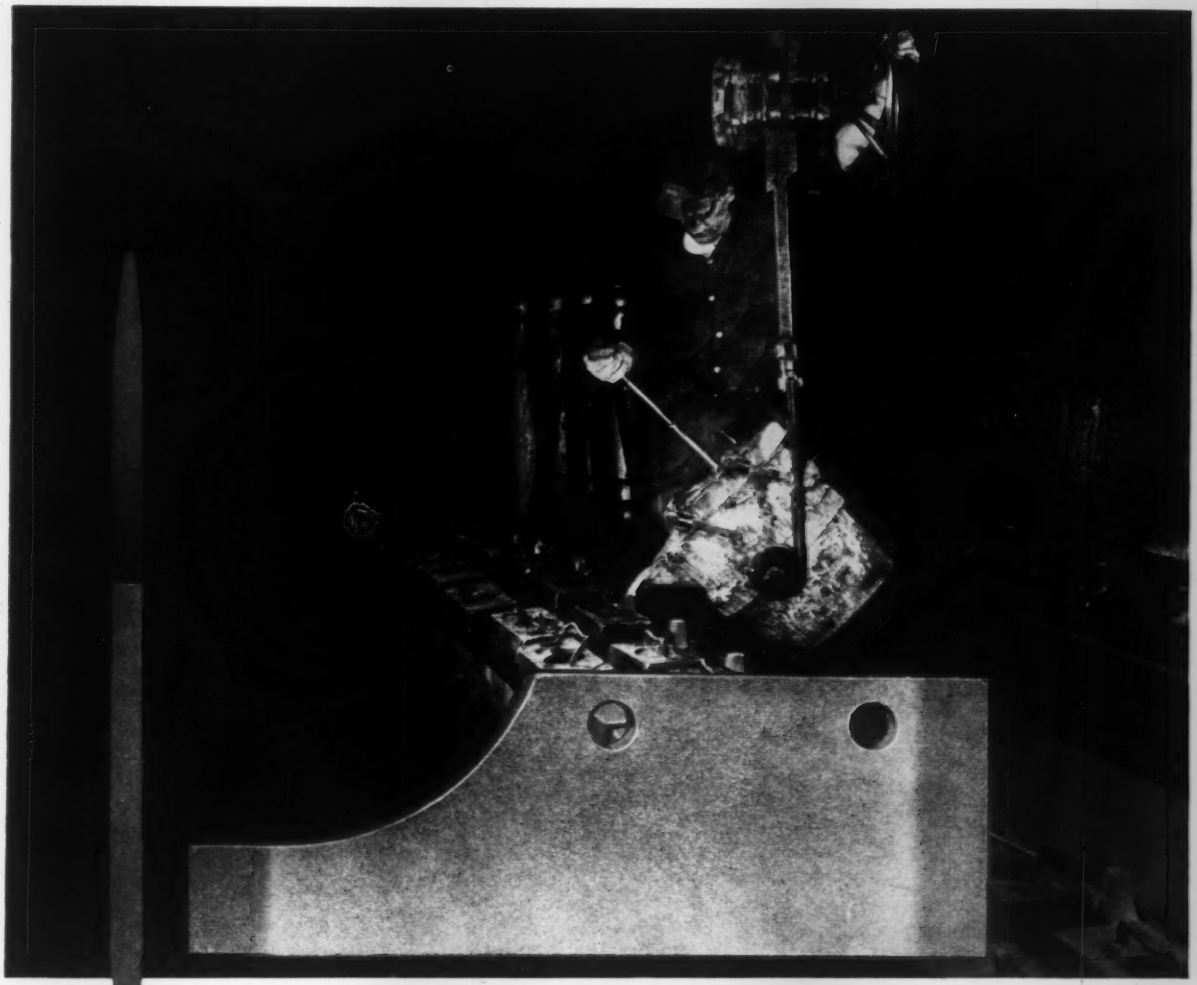
Ten-position headrests (left) available singly or in pairs, give added comfort when seats are reclined. They also serve as safety devices by helping to prevent neck injuries in rear-end collisions.

Air bellows and coil springs (right) are combined in American Motor's relatively simple Air-Coil Ride. The optional air-suspension system also levels the car automatically when loads are added.

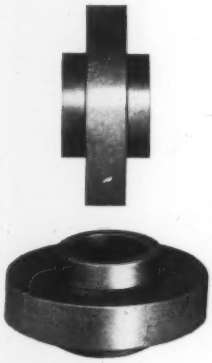
Uncluttered look (below) is a feature of the '59 Rambler American instrument panel. All operating gages are grouped in a single cluster directly in front of the driver.







This customer SAVED TWICE with Ampco Shell Moldings



Gear blank shell-cast in Ampcoloy nickel bronze. Surface finish was held to ± .015. Only finishing required was to hob teeth and broach key-way. Savings were considerable.

In the wear strip above, shell-cast of Ampco Metal, all dimensions including end-bevels and hole locations were held to ±.015. The smooth surface finish required no machining. Substantial savings of time and money were realized.

With Ampco Shell Moldings, castings can be held to extremely favorable tolerances. Finishing operations are often eliminated; less metal is wasted. More of the tough outer cast shell is retained, providing longer service life.

Casting detail is excellent — oil grooves, deep pockets, and recesses can be cast in, and coring is close and precise, for complex designs impractical by other methods. High production rates reduce molding costs.

Ampco Shell Moldings are available in an extremely wide range of copper-base alloys. Ask an Ampco field engineer to tell you more about this money-saving production process. And write for Bulletin G36-957. *Ampco Metal, Inc., Dept. 30-J. Milwaukee 46, Wisconsin. (West Coast Plant: Burbank, Calif. — Southwest: Garland [Dallas County], Texas)*

G-16

AMPCO

ONE-SOURCE SERVICE FROM RAW MATERIAL TO FINISHED PRODUCT

Circle 414 on Page 19

Quick-As-Wink Solenoid Air Valves on Battery of Heavy Duty Presses.

HUNT CONTROL Valves

Quick-As-Wink Valves on Tire Mold Handling Machine.

Quick-As-Wink Valve on 8-spindle Automatic Chucking Machine.

proven dependable operation

no after hours Siss-s-s-s

That harsh sizzling noise you hear out in the plant, after the work force has gone home, is there during the day also. Only you can't hear it then. It's air, seeping out through inferior valves, wasting from $5.00 to $500.00 per month. And leaky valves mean sloppy machine control; danger of "repeating"; possible injury to the operator; or a breakdown involving costly repairs, material spoilage, lost production and customer ill-will.

Stop the s-i-z-zling by installing Hunt valves on all your air and hydraulic controls. Positive and fast-acting Hunt valves are designed and built to seal tightly, preventing leaks, and minimizing the danger of breakdowns and tie-ups. Sizes from ⅛″ to 8″. 29 Hg vacuum to 250 p.s.i.; up to 5000 p.s.i. on oil and water. *Zero leakage.* Recognized by operators, foremen and superintendents everywhere for unsurpassed economy, low maintenance and long, efficient service.

HUNT

Quick-As-Wink® AIR AND HYDRAULIC CONTROL Valves

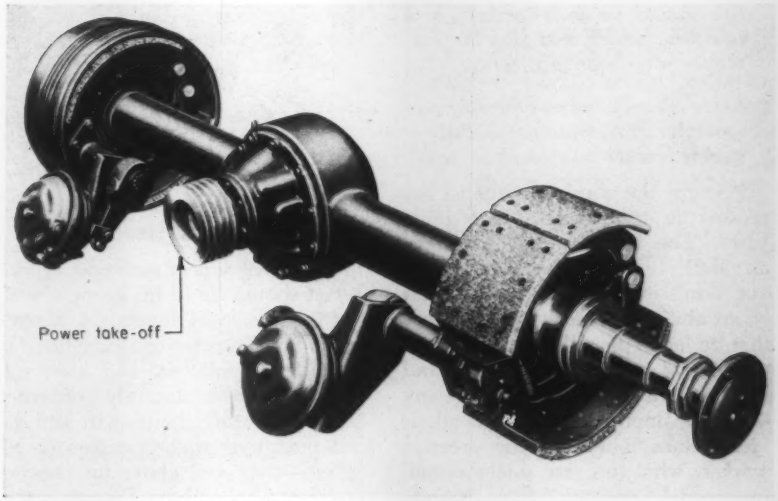
Manufactured by HUNT VALVE COMPANY, 2011 East Pershing St., Salem Ohio

Circle 415 on Page 19

New Carriers: Clubs and Pipes

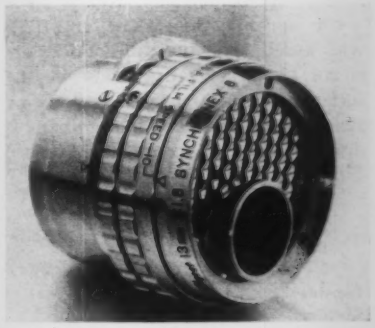
Good mileage on the golf course—72 holes per gallon—is claimed for this lightweight motor scooter with a plastic body. Fenders, body, and seat are laminates of epoxy resin and glass fiber, which reduces over-all weight of the scooter from 250 to 165 lb. Plastic body also quiets engine noise and does not become uncomfortably hot to the touch after a few hours in the sun. Developed by Bobcat Corp., Wheeling, Ill., the scooter doubles as a caddy and as transportation to and from the course. Epoxy resin used in construction, compounded by Ren Plastics Inc., Lansing, Mich., has fade-resistant color pigment added.

Fifteen joints per day, each one requiring the placement of a 68-ton concrete pipe, is an average performance for this diesel-electric pipelayer. Built by American Pipe & Construction Co., the 80-ton vehicle is powered by direct-current drive motors mounted on each of four rear wheels and two front wheels. A single wheel, mounted forward at the end of a heavy-duty hydraulic cylinder, carries the load when front wheels are elevated for passing inside pipe. Internal expanding-contracting rams hold pipe snugly during travel. Tires on all seven wheels are 21.00-25 14-ply nylon, developed by Goodyear Tire & Rubber Co.



Cool-Trailer Axle

Live axle for semitrailers has a power take-off sheave that rotates whenever the trailer rolls. Purpose is to provide a drive for mobile refrigeration compressors and other truck accessories. The axle eliminates the need for small gasoline engines often used for auxiliary power. To hold trailer temperatures down during long stops, an electric motor for plug-in service is suggested. Manufacturer of the axle assembly is the Transmission and Axle Div., Rockwell-Standard Corp.



Mechanical Eye

Change in light intensity automatically and continuously adjusts the iris in a packaged f1.8 lens and photocell unit. Called Synchronex-8, the assembly is for use with 8-mm movie cameras. Control can be set for film with speed range from ASA 10 to 16, and manual settings are provided for greater versatility. Acceptance angle of the cell is designed to collect all light within the area photographed. Extraneous light cannot influence accuracy. Manufacturer is Elgeet, Rochester, N. Y.

the ideal creative supervisor

part 3

By EUGENE RAUDSEPP
Research Consultant
Deutsch & Shea Inc.
New York

THE CREATIVE-GROUP supervisor has to have a well-rounded set of abilities—not only in technical matters, but also in personal leadership and handling of his group. But what are the specific characteristics required of the "ideal" supervisor?

A panel of experts—105 of them—on various phases of creativity was asked this question. Their answers have been presented in this series of three articles. Previous articles were in the September 18 and October 2 issues of MACHINE DESIGN.

The Ideal Creative Supervisor Should

Be a Tactful Critic

The creative supervisor should be open-minded and receptive toward ideas and suggestions offered by his group. At all times he should be a good, understanding listener. If he must criticize, he should do so skillfully and tactfully. "Tactfulness" and "diplomacy" were attributes frequently mentioned by the panelists:

- *He can employ judgment diplomatically*
- *He should be a tactful evaluator*
- *He has a firm belief in the "golden rule"*
- *If he has to turn down an idea, this should be done tactfully and in a way which will give the employee some ego satisfaction*
- *He should have a healthy respect for the opinions of the research worker*

Perhaps the way one panelist expressed it crystallizes this attitude best: "The supervisor should have an ability to evaluate ideas without using external evaluation, that is, an ability to react to ideas rather than to judge them."

Creative people are, by and large, extremely sensitive to any overt or implied criticism of their ideas. Rare indeed is the creative worker who has an unemotional, impersonal, and objective attitude toward criticism, who has learned to ignore unfounded criticism and benefit from that which is justified and useful. This ability to be coolly objective about criticism comes only in time and is based on a series of solid successes in creative work. Even then—perhaps because of the creative person's need always to prove himself anew—he never fully achieves indifference to criticism. No matter how tough the creative worker, overcritical attitudes, cynicism, ridicule, or even plain indifference on the part of the supervisor is tremendously destructive of idea-producing ability.

The Ideal Creative Supervisor Should

Service Group's Needs

The ideal supervisor's primary interest should lie in his group's well-being. The ideal supervisor is seen, as summed up by one panelist, "as a selfless, confident, and alert role player" who is sincerely concerned with promoting the growth and development of each member of his group—over and above the concern he might have about his own status and prestige.

His dual role as protector and servicer involves handling all the administrative work of his group, providing the necessary materials and facilities, and protecting his group from time-consuming "fire-

How "Ideal" Can You Get?

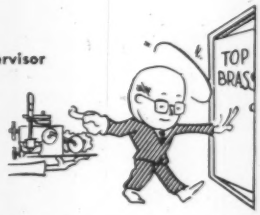
Here's how Gordon C. Lange of Swarthmore Creative and Development Services summarizes his conception of the ideal creative supervisor:

An experimental type of mind, with a courageous heart, the patience of a saint and the spiritual development of a Ghandi. The constitution of a horse would help. All of this has to be balanced and controlled by an over-riding tanacity of purpose. In short, the ideal doesn't exist, but we can and should search for him!

fighting" jobs and other unreasonable demands and pressures.

For example, Hugh P. McGee, the head of the Special Applications Branch of the U. S. Navy Underwater Sound Laboratory stated that the main function of the supervisor is "to make the group feel that his main interest is in the people in the group, in their work, and their rewards and facilities. He should also make them feel that he is strong enough to get them the things they need whenever the job warrants it." Dr. Finsterbach feels that "above all, the 'ideal' supervisor should be able to 'fight' for his group and back them against all odds, for this will be his constant battle."

The Ideal Creative Supervisor Should



Be Group's Spokesman

The ideal supervisor can help his group even better if, as Kenneth E. Brigham of Sperry Gyroscope points out, "he has the ability to get along with management while protecting the group under him."

Several panelists suggested that he should not only be able to get along with management, but should have considerable influence with them. A direct, personal pipeline to several people on the management staff also helps. Otherwise, the aggressive energy he displays for the support of the group and its projects will come to naught, and morale will suffer. Panelist Dr. Herbert A. Shepard of Esso Standard Oil Co. says that influence with management has a direct bearing on morale and enthusiasm:

•*There is a general tendency for high performance to be associated with members' ability to influence the supervisor in matters affecting their work. However, this influence is marked only if the supervisor is correspondingly influential with the laboratory management. If he is not, the morale and enthusiasm of the supervisor's group tend to be low.*

The Ideal Creative Supervisor Should

Give Credit Fairly

Another attribute of the ideal supervisor is the equitable and fair giving of credit. He should, according to professor William H. Middendorf of the University of Cincinnati, "be able to convince members of his group that they will be properly identified with their part in success." A few panelists, notably A. L. Simberg of AC Spark Plug Div. of General Motors, suggested that "a definite and formal system should be established for the fair and consistent consideration of all ideas conceived in the department." Whether such a formal system exists or not, the supervisor should consider all new ideas, give praise when praise is due, and reward efforts immediately by appropriate action.

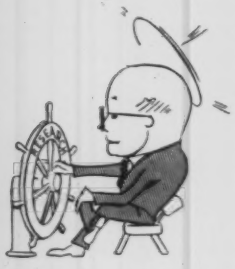
The Ideal Creative Supervisor Should

Assign Responsibility Skillfully

Several panelists touched on the subject of delegating responsibilities and assigning work. It was felt that the supervisor should be careful in delegating technical responsibility to avoid antagonizing his people. According to Dr. Danzig, "He should know his group so well as individuals that he can make assignments that will conform to the personalities, interests, and abilities of the individuals." This requires knowledge of each individual's particular strengths and weaknesses so

that each is assigned a problem where his chances for contribution are the greatest.

Recognizing that fascination with a problem area is highly correlated with creative success in it, Professor Mooney offers this advice to supervisors: "Find out where individuals think they are most creative or would like to be most creative, and what sort of creative contribution they would most like to be able to make to the company if they could." The highest kind of creativity cannot emerge when individuals have been pushed into solving a problem.



The Ideal Creative Supervisor Should

Control "Lightly"

After breaking the project down into manageable assignments and properly assigning them to individual workers, the supervisor should, according to several panelists, leave each creative worker either completely alone, or exert minimum direct influence on him. This is especially true in regard to the particular approaches to problems each man may want to adopt.

He should make sure that his instructions do not incorporate his own ideas about the approach to be used in attacking the problem. It often happens that staff members, especially the younger ones, may mistakenly feel that they could not top the suggested idea. They may, out of fear of antagonizing the supervisor, not dare to come up with a better suggestion.

The supervisor's timing on when to take the idea from the individual contributor is, according to Professor Mooney, also crucial.

- *New ideas, like all new creatures, are tender and fragile; they are dependent on the personal care of the one giving them birth. To take a new idea away from its creator too soon is likely to injure him in a way he will resent as a personal insult; it is also likely to endanger the life of the idea. By the same token, not to take a man's ideas after they have matured is often as damaging, and for the same reasons. He is likely to feel that neglect or rejection of his ideas is somehow neglect or rejection of him.*

The panelists in this study disagreed about how actively the supervisor should direct a project. Some panelists felt that he should lead and enthuse by suggestion rather than by specification and, in general, practice a hands-off policy once the work has been assigned. Others suggested a closer management of the efforts of the people in the group:

- *He should maintain reasonable order and constantly tug at the direction of the individuals, to keep them reasonably close to their objective*
- *He should direct and time the different phases of the creative process*
- *He must be a disciplinarian without seeming to be one*

These remarks suggest a desire for closer control in the management of projects. But even here, what is suggested is more in the nature of "subtle leadership" with none of the coercion, dominance, and authoritarianism traditionally associated with management. The studies of Dr. Pelz throw considerable light on what the optimum degree of control should be:

- *The results show that performance is slightly higher under an intermediate degree of independence, rather than under full dependence or full independence. Junior scientists benefit somewhat more from "mutual influence" between chief and subordinates; senior scientists benefit somewhat more from "separation." It seems plausible that too much independence may deprive the subordinate of the stimulation that a competent chief can provide. On the other hand, too close dependence on the chief may stifle individual initiative. By this line of reasoning, highest performance should result if we can combine the benefits of frequent stimulation with the assurance of freedom for initiative.*

Company Climate and Creativity

This series of three articles on the ideal creative supervisor is part of a comprehensive survey, *Company Climate and Creativity*, conducted by the Research Department of Deutsch & Shea Inc., technical manpower consultants, to be published by Industrial Relations News in November. The complete survey (over 150 pages) will also cover questions such as:

How much freedom for creative research?

Special rewards for invention: pro and con.

Top management's role in creative research.

What motivates the creative person?

Barriers to creative climate in the industrial setup.

How much does industry encourage creativity?

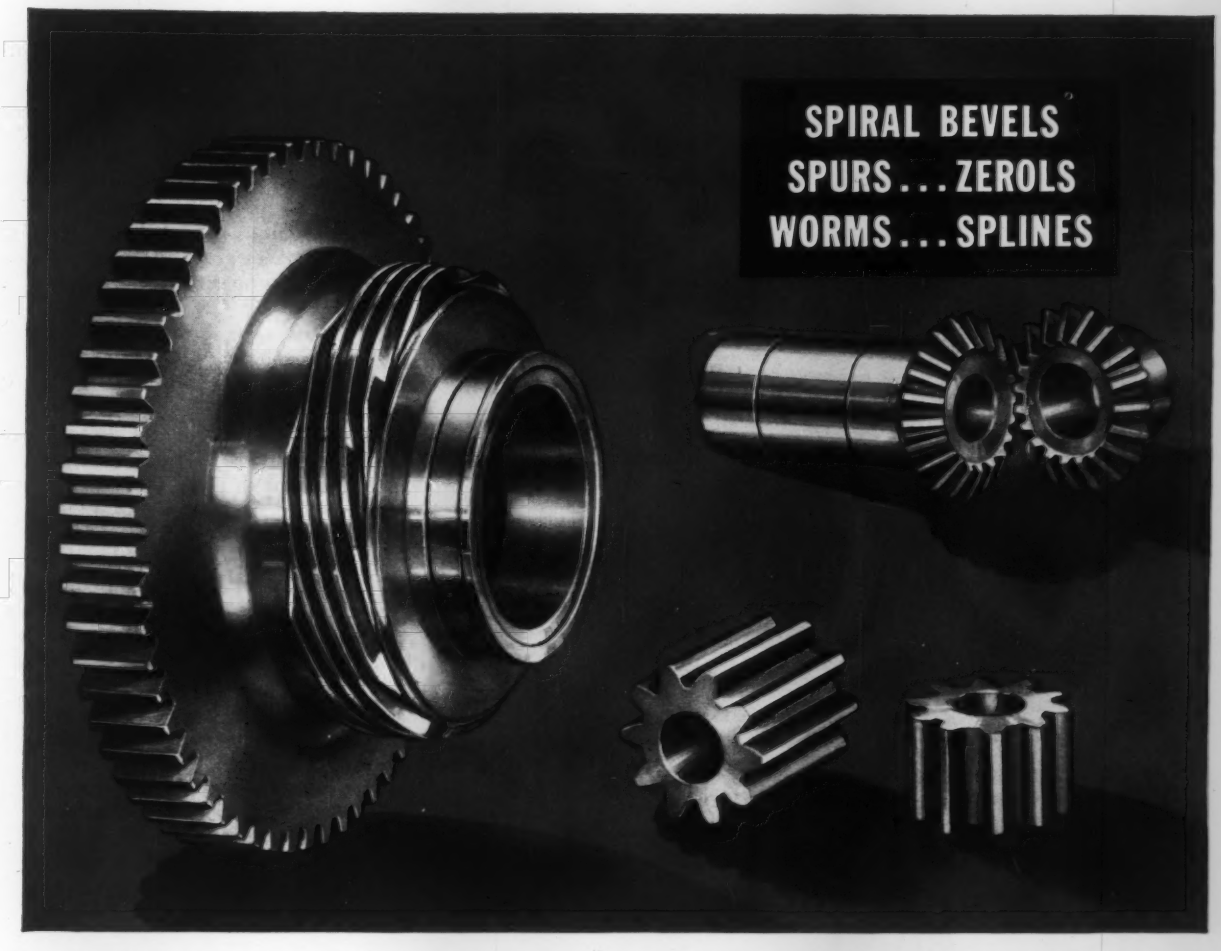
Copies will be available for $10 each from Industrial Relation News, 230 West 41st St., New York 36, N. Y.

The Well-Rounded Supervisor

The ideal supervisor is visualized as a sympathetic, friendly person who likes both people and ideas. He is able to relate co-operatively and stimulatingly with his subordinates. He is a pleasant, easy-to-get-along-with person who has high standards of integrity and who can be, depending on circumstances, either serious and sincere, or humorous and relaxed.

One of his most significant attributes is his ability to be patient, tolerant, and extremely flexible in both thinking and acting. For him nothing should be frozen, stable, static, or permanent.

Unlike his noncreative colleagues who build up a comfortable little system or channel in which to op-



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Every precaution must be taken to avoid dimensional distortion in many critical gear applications—such as, for example, with the Spur and Worm combination at the left and the Zerols at top right (both for aircraft uses); or where exceptionally high finish is desirable to give smoother unit performance, as with the Spur Gears (for a pump application) at the lower right of the illustration.

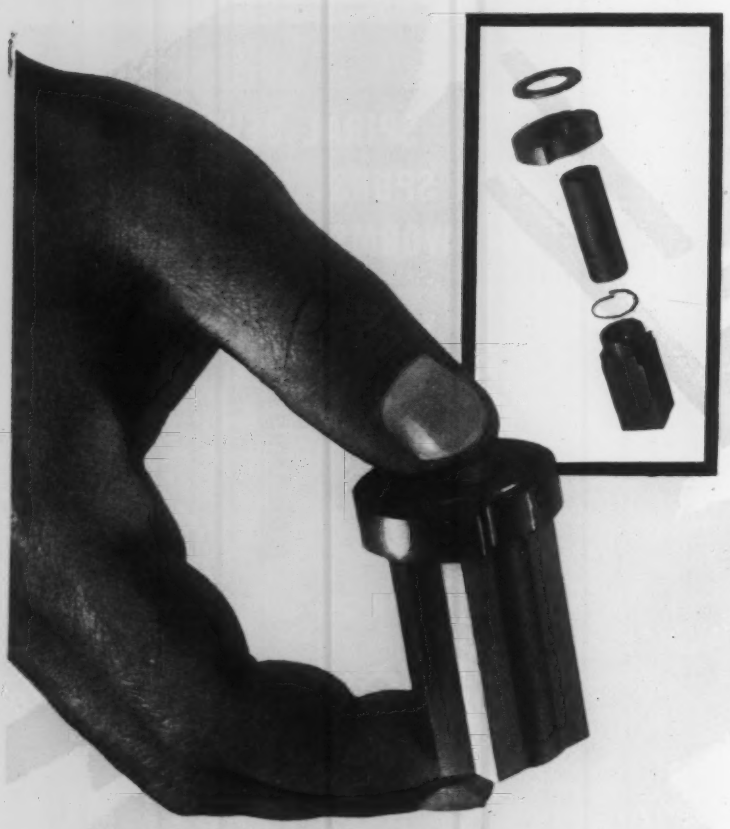
Special equipment of the most modern design allows G.S. to handle such requirements most effectively with ground teeth. This method of manufacture corrects heat-treat distortion which takes place with hardened gears, as well as permitting extremely high finish.

G.S. can supply ground teeth in Spur Gears as fine as 24 pitch up to 8 d.p.; in Zerols or Spiral Bevels, from 24 d.p. to 6 d p.; in Worms, from 96 d.p. to 8 d.p.; and straight side or involute Spline Shafts.

This is only one of the many special operations which can be provided in our magnificently equipped plant—or we can supply you units with less complex requirements, made with custom precision at production-run economies. Call in our skilled engineers to discuss your problems—it's worth a lot to have G.S. on your production team!

42 Years of Specializing in Small Gearing!

Circle 416 on Page 19



ONE PART REPLACES FIVE!

BY POWDER METALLURGY

Tremendous savings and performance advantages resulted when Dixon Sintaloy Engineers, in collaboration with the Briggs & Stratton Corporation, redesigned this five-piece cam and ratchet as a single powder metallurgy part. Excellent bearing qualities plus self-lubrication of the Sintaloy iron-copper part eliminated the need for the bronze bearing insert and thrust washer. The cam is now integrally formed and heat treating provides the required surface hardness. Since the ratchet no longer has to be machined from stock shapes, the most efficient contour can be employed and formed right in the part. Delivered to Briggs & Stratton, ready-to-use, the Sintaloy part with inherently fine surface finish and close tolerances, minimizes inspection, eliminates further finishing, simplifies inventory, and frees production facilities for other work.

These are but some of the outstanding advantages of Sintaloy Powder Metallurgy in one particular case. It costs nothing to determine how it can also provide similar advantages for you. Write today for illustrated brochure with full design data.

DIXON SINTALOY INC.

a subsidiary of The Joseph Dixon Crucible Company
535 Hope Street, Stamford, Connecticut

erate and into which their sense of stability can easily flow and solidify, the creative supervisor has no need for the doctrinal mode of thinking. He feels rather that he can take nothing for granted, and that the volatile, evolving and unconfined reaches of technological advances have not even been tapped as yet.

He has also, to borrow Dr. Carl Rogers' felicitous phrase, "openness to experience," in that he is continuously open to all the overwhelmingly complex and contradictory ramifications of experience. He has no desire to close out, ostrich-fashion, the conflicting and ambiguous elements he encounters. He has, as Dr. Rogers puts it, "the ability to receive much conflicting information without forcing closure upon the situation." Dr. McPherson also feels that he has to be able to "handle and tolerate the ambiguities of his situation. He must not be too impatient with fluid situations."

His one outstanding skill should be in the area of communications. This skill should span areas like "ability to express problems clearly," "ability to guide by questioning," "ability to lead and arbitrate discussions," "ability to ask intelligent, searching questions that stimulate, spur, and encourage thinking and work," etc. Upon him falls the responsibility to maintain open, effective communications within his department or group, with other departments in the company and with management.

"Here he comes again. I recognize the walk."

Circle 417 on Page 19

Metals Matters

Beryllium-Oxide Shapes

Large, high-purity hot-pressed and machined beryllium-oxide shapes are being produced by the Beryllium Corp. The material's characteristics—low neutron capture cross-section, high thermal conductivity, high electrical resistivity, and high dielectric strength—make it applicable for use in the nuclear, aircraft and missile, and electronics industries. Melting point is 4658 F; tensile strength is 8000 psi and compressive strength is 60,000 psi at 2000 F; modulus of elasticity is 43 x 10^6 psi.

Copper-Base Alloys

New authoritative data on the mechanical and physical properties of the three most common copper-base casting alloys have been determined. Previously known only through historic record with no proof of accuracy, these properties have now been "proved" through research at Battelle Memorial Institute under the sponsorship of the Brass & Bronze Ingot Institute. Complete details of the studies will be published in two papers by the American Society for Testing Materials; free reprints will be available from the BBII, 308 W. Washington St., Chicago 6, Ill.

High-Strength Steel

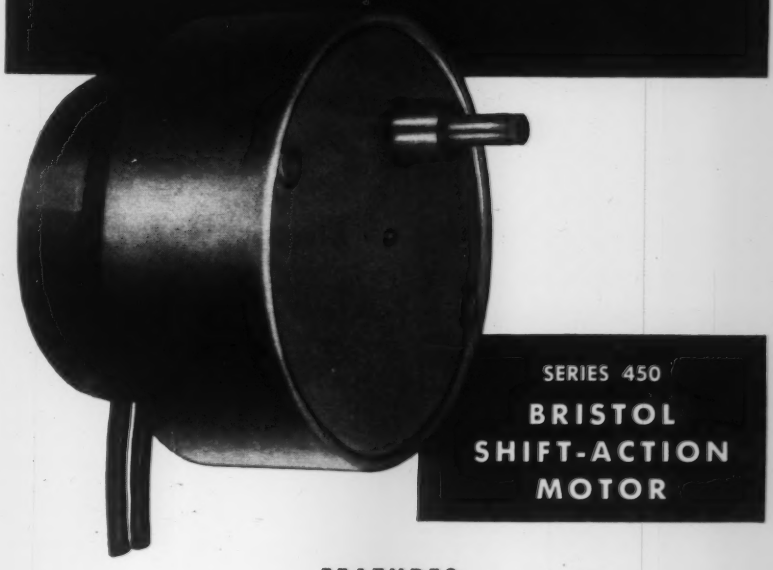
Jalcase 100 eliminates, in most cases, the need for heat treatment during the production of wear-resistant parts. The improved high-strength, stress-stabilized, free-machining, cold-finished bar steel is produced by Jones & Laughlin Steel Corp. Other features are: Guaranteed minimum yield strength of 105,000 psi and guaranteed minimum hardness of 248 Brinell in sizes up to 1½ in. diam. Stresses that normally result in distortion after machining are carefully controlled. Chemical analysis of the steel is equivalent to AISI grade C-1144.

Rust Preventive

Tarnishing and rusting of iron and steel parts after surface finishing does not occur if the metal has been treated with a new compound developed by Roto-Finish Co., Kalamazoo, Mich. Compound 117-C, a blend of alkaline materials, neutralizes the effects of acids used on metal surfaces during barrel finishing to remove scale.

Manufacturer of the nylon tie and installing tool described on page 36 of the October 2 issue of MACHINE DESIGN is Thomas & Betts Co., Elizabeth, N. J.

NEW INTERNAL SHIFT MOTOR



FEATURES

1. Positive Solenoid Shift Action.
2. Dependable – May be mounted in any position.
3. Compact – 2-inch diameter x $1\frac{21}{64}$ inches in depth.
4. Torque – Rated at 9 in. ozs. at 1 RPM.
5. Priced lower than competing units.
6. Speeds – Available in all standard speeds between 1 RPM and 180 RPM.
7. Available for immediate delivery.

BRISTOL MOTORS

CIRCLE B BRISTOL

DIVISION of VOCALINE COMPANY OF AMERICA, INC.
107 COULTER ST. • OLD SAYBROOK, CONN.

WHEN SECONDS COME FIRST — SEE BRISTOL FIRST!

Circle 418 on Page 19

PUMP DESIGN TRENDS

by Arthur A. Nichols

THREE LOW COST COMPONENTS REPLACE COMPLETE PUMP...

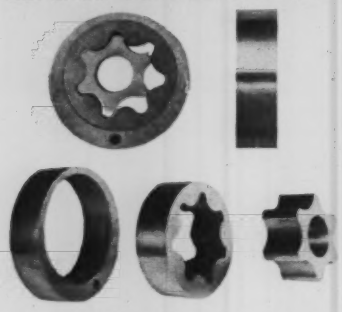


Fig. 1. Three Gerotor components permit pump to be incorporated as integral part of housing or frame of mechanism, eliminate need for purchase and mounting of separate, complete pump.

A growing concept in pump application practice . . . *integral design* . . . opens up an important new opportunity to cut pump costs.

Purchase of complete pumps can be eliminated by incorporating a 3-component unit directly into your mechanism. Consisting of an inner and outer Gerotor and an eccentric locator-ring, the unit becomes a complete pump by simply through-boring the casting or frame of the mechanism to accommodate the locator ring O. D. and by providing porting. This design makes the main casting do double duty as the pump housing, thus eliminating a very considerable cost factor. A drive can be taken from any convenient shaft.

The matched elements are thus as easily built-in as a simple anti-friction bearing would be. Further, the Gerotor pump is extremely flexible in its configuration and readily adapts to a wide variety of mechanism geometries. It will handle a variety of fluids at rates up to 100 gpm and pressures up to 1,000 psi.

The Gerotor pump is a positive displacement type, delivering a predetermined amount of fluid in direct proportion to speed. It is a form of internal gear pump — simple and compact in basic design, (has only two moving parts). It is lightweight, valveless, provides exceptional performance and has low wear over a long service life. It is balanced and extremely quiet in operation.

The Nichols insert-package eliminates mounting pads, couplings, connectors, accessory drives and similar costly items and does away with buying finished pumps. Our technical assistance is available to you at all times and you are cordially invited to write for specific information on how this new concept can be adapted to your current designs.

W. H. NICHOLS CO.
38 Woerd Ave., Waltham 54, Mass.

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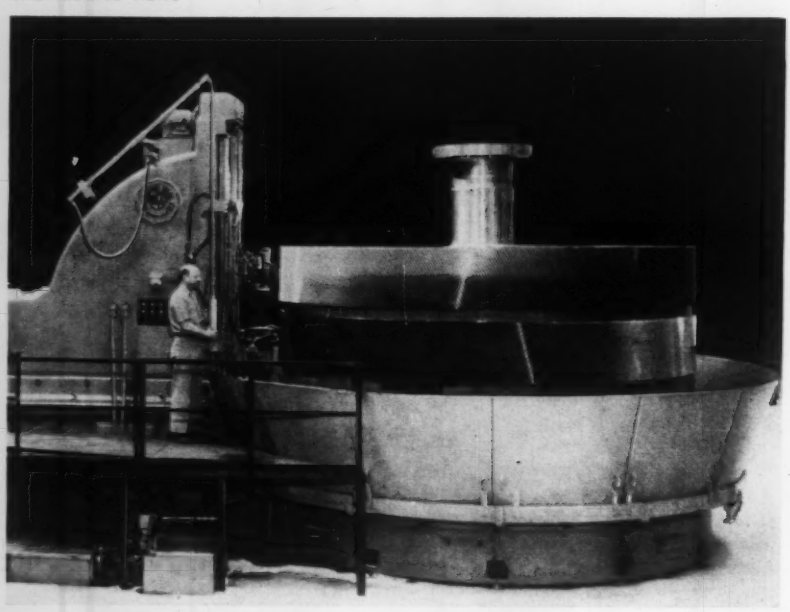


No Little Shaver

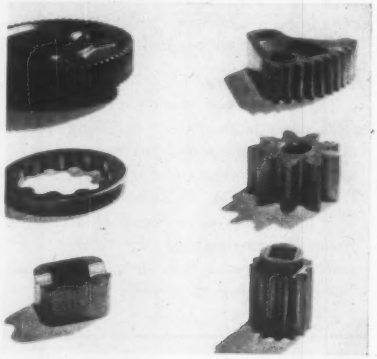
Big gears, ranging from 80 to 200 in. in diameter, with face widths up to 74 in., are handled by this new vertical gear shaver, called the world's largest. The machine is also remarkably accurate—within 0.0002 in. of runout in the flat plane of rotation on workpiece loads of 150,000 lb. The extreme accuracy is attained by a unique assembly method: When the machine is first assembled by its manufacturer, Michigan Tool Co., Detroit, strain gages are used to make a continuous record of any deflections and strains. Subsequently, when the machine is reassembled in the user's plant, the same gage readings are set to assure the same final precision.

New Alloy Iron Powder Tests to 100,000 psi

CLEVELAND—Ductile powder-metallurgy parts fabricated from a new low-alloy iron powder have tensile strengths equal to those of conventionally wrought or cast metals. Containing small quantities of alloyed nickel and molybdenum, the high-strength powder (Type 6640) develops a minimum tensile strength of 60,000 psi as sintered, and 100,000 psi after heat treating, according to its developer, Republic Steel Corp.

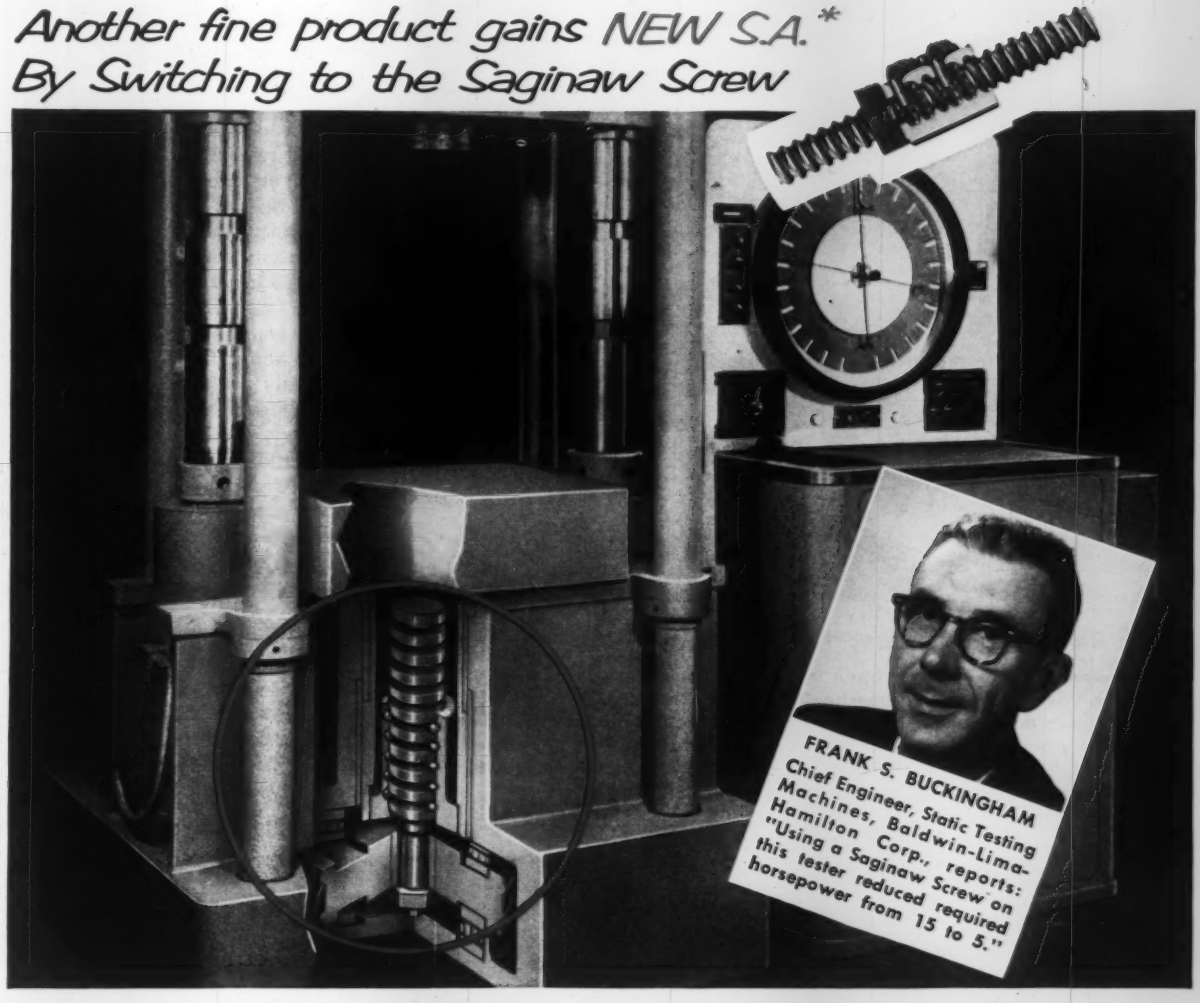
Fabrication of components from Type 6640 powder is by normal techniques: briquetting pressures are 30 to 35 tons for a density of 6.4 gm per cu cm; sintering cycle is 45 min at 2030 to 2050 F. Dimensional characteristics after sintering fall within accepted industry tolerances (maximum 0.004-in. shrinkage from die size at 6.4 density).

Republic has simplified design application of the new powder by making available graphical data on physical characteristics such as tensile strength, dimensional change, green density vs. sintered density, and briquetting pressures.



Application of Type 6640 high-strength, low-alloy iron powder will be in the fabrication of small component parts in the automotive, appliance, and hardware industries.

Another fine product gains NEW S.A. By Switching to the Saginaw Screw*


FRANK S. BUCKINGHAM
Chief Engineer, Static Testing Machines, Baldwin-Lima-Hamilton Corp., reports: "Using a Saginaw Screw on this tester reduced required horsepower from 15 to 5."

WORLD'S MOST EFFICIENT ACTUATOR OPERATES 75-TON BALDWIN TESTER WITH 5 H.P. INSTEAD OF 15

When you can cut power requirements 66% you give your product a lot more ***S**ales **A**ppeal—and that's just what Baldwin-Lima-Hamilton has done by switching from an acme thread to a preloaded Saginaw b/b Screw. What's more, it speeds up cycling and ends fretting corrosion, too.

The truly amazing ability of the Saginaw Screw to convert rotary motion to linear motion with over 90% efficiency is saving power, space, weight and assuring smoother, more dependable performance in countless products from miniature electronic controls to giant production equipment.

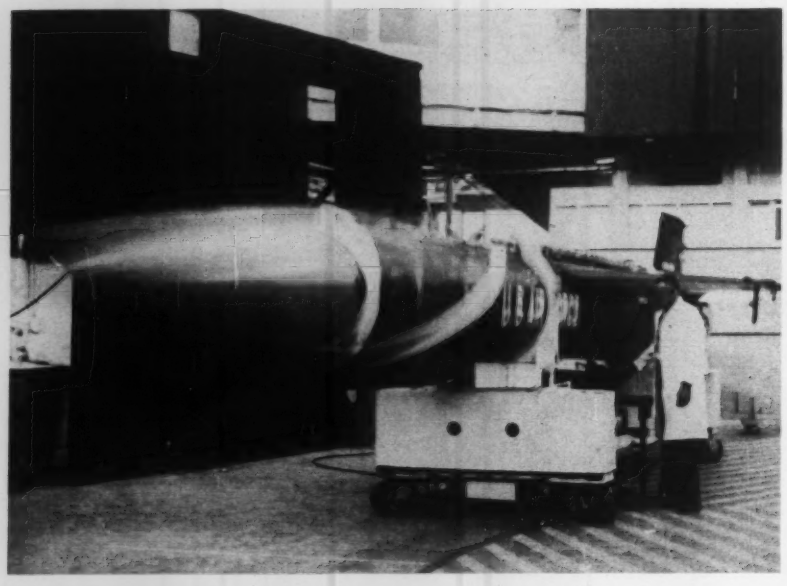
Perhaps the Saginaw Screw can give *your* products that vital new **S**ales **A**ppeal you're looking for right now. To find out, write or telephone Saginaw Steering Gear Division, General Motors Corporation, Saginaw, Michigan—*world's largest producers of b/b screws and splines.*

**Give your products NEW SALES APPEAL... switch to the*

Saginaw

ball bearing Screw

Circle 420 on Page 19



Rough Ride for the Bomarc

Fast checkout for the guidance brain in Boeing's Bomarc missile is given on the production line by a missile "exerciser." Bumping, bucking, swaying, and rolling, the Bronco dolly puts the missile's autopilot through a rugged 2½-min simulated flight sequence. Use of the special dolly—which gets its bounciness from four air springs—permits the missile to ride from the assembly line through inspection and testing with minimum handling.

Ductile Beryllium Castings Goal of Air Force Study

READING, PA.—Production of cast ingots of ductile beryllium is the goal of a research and development program awarded Beryllium Corp. by Air Materiel Command. Beryllium, a metal three times stronger than steel on the basis of strength-weight ratio, retains its high strength at temperatures up to 1200 F, and has made a name for itself by doing "impossible" jobs.

Presently all commercial-grade beryllium is fabricated by powder metallurgy because production ingots of the metal are not suitable for further wrought processing. The ingot-powder-processing procedure is both lengthy and costly. The Air-Force sponsored study will investigate the possibility of producing castings of beryllium by more conventional processes, including centrifugal, pressure, and vacuum castings. This will probably lead to lower costs for the metal. The Air Force has already expressed considerable interest in using beryllium for structural applications.

Meetings

AND EXPOSITIONS

Oct. 26-31—

American Institute of Electrical Engineers. Fall General Meeting to be held at the Penn-Sheraton Hotel, Pittsburgh. Further information is available from AIEE headquarters, 33 W. 39th St., New York 18, N. Y.

Oct. 27-31—

American Society for Metals. National Metal Exposition and Congress to be held at the Public Auditorium, Cleveland. Additional information can be obtained from ASM headquarters, 7301 Euclid Ave., Cleveland 3, Ohio.

Oct. 29-30—

Computer Applications Symposium to be held at the Morrison Hotel, Chicago. Sponsor is the Armour Research Foundation of Illinois Institute of Technology. Further information can be obtained from Dr. Frederick Bock, Electrical Engineering Research Dept., ARF, 10 W. 35th St., Chicago 16, Ill.

Oct. 30-31—

Aircraft Electrical Society. Fifteenth Annual Display of Aircraft Electrical Equipment to be held in the Pan Pacific Auditorium, Los Angeles. Additional information can be obtained from society headquarters, 3540 Wilshire Blvd., Los Angeles, Calif.

Nov. 5-6—

Society of Automotive Engineers Inc. National Fuels and Lubricants Meeting to be held at The Mayo, Tulsa, Okla. Additional information is available from SAE headquarters, 485 Lexington Ave., New York 17, N. Y.

Nov. 10-12—

Steel Founders' Society of America. Thirteenth Technical and Operating Conference to be held at the Pick-Carter Hotel, Cleveland. Further information can be obtained from society headquarters, 606 Terminal Tower, Cleveland 13, Ohio.

Nov. 10-14—

National Electrical Manufacturers Association. Annual Meeting to be held at the Traymore Hotel, Atlantic City, N. J. Further information is available from NEMA headquarters, 155 E. 44th St., New York 17, N. Y.

Nov. 12-14—

Society for Experimental Stress Analysis. Annual Meeting to be held at the Sheraton-Ten-Eyck Hotel, Albany, N. Y. Further information is available from society headquarters, P. O. Box 168, Cambridge 39, Mass.

Nov. 12-15—

Society of Naval Architects and Marine Engineers. Annual Meeting to be held at the Waldorf-Astoria Hotel, New York. Further information can be obtained from society headquarters, 74 Trinity Place, New York 6, N. Y.

Nov. 17-21—

Society of the Plastics Industry

FROM END TO END . . . INSIDE AND OUT . . . MADE RIGHT IN OUR OWN PLANT
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Springfield, Mass.
Springfield
"400"
There is nothing like Teflon flexible hose for tough applications. Now, for the first time, you get "finger flexibility" in large diameters up to four inches with Springfield "400" . . . an exclusive new development by Titeflex. Short bend radius, long lengths, plus "Zero Motion Braid" make Titeflex Springfield "400" the big news in Teflon hose. Write for complete information, Bulletin 400.

Circle 421 on Page 19

how much can
BETTER QUALITY
FASTENERS
save you?

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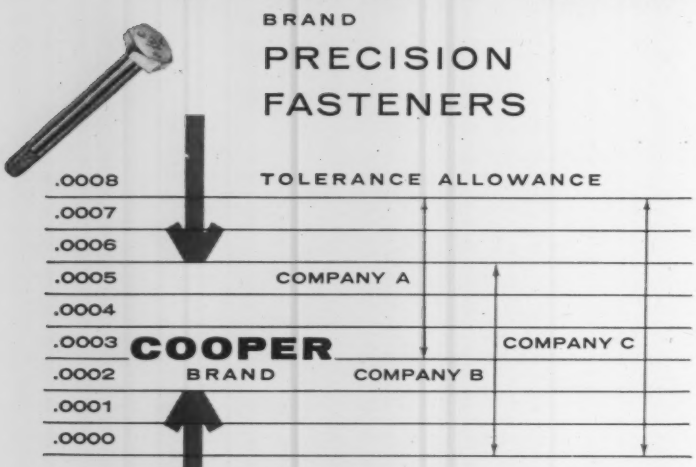
BRAND
PRECISION
FASTENERS



Your present fasteners may be causing you no reported breakdowns in your finished product, but what is the real story on your assembly line? Too many "headaches" there? Too much time spent on misfits that (like Fasteners A, B & C above) come "within tolerance", **but are actually unprofitable for you** because of time wasted?

Are you, in fact, "living with" problems that are costing you more than it would to **eliminate** them with better quality—Cooper brand quality—fasteners?

A Cooper specialist will be glad to help you avoid many of these headaches and needless costs. Our Metrology Laboratory is also ready to assist you with any of your screw thread problems. Just call us.

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Division of Standard Pressed Steel Co., Jenkintown, Pa.

Circle 422 on Page 19

Inc. National Plastics Exposition and Annual Conference to be held at the International Amphitheatre, Chicago. Further information can be obtained from society headquarters, 250 Park Ave., New York 17, N. Y.

Nov. 18-20—
American Standards Association. Ninth National Conference on Standards to be held at the Hotel Roosevelt. Further information can be obtained from ASA headquarters, 70 E. 45th St., New York 17, N. Y.

Nov. 30-Dec. 5—
American Society of Mechanical Engineers. Annual Meeting to be held at the Statler-Hilton and Sheraton-McAlpin Hotels, New York. Additional information can be obtained from ASME headquarters, 29 W. 39th St., New York 18, N. Y.

Dec. 1-3—
American Society of Refrigerating Engineers. Semiannual Meeting to be held at the Roosevelt Hotel, New Orleans. Additional information is available from society headquarters, 234 Fifth Ave., New York 1, N. Y.

Dec. 1-5—
23rd National Exposition of Power and Mechanical Engineering to be held at the Coliseum, New York. Exposition is under the auspices of ASME. Further information is available from International Exposition Co., 480 Lexington Ave., New York 17, N. Y.

Dec. 2-4—
Electronic Industries Association. Conference on Reliable Electrical Connections to be held at the Statler-Hilton Hotel, Dallas. Further information is available from Mr. R. George Roesch, 1068 S. Clinton St., Syracuse 4, N. Y.

Dec. 8-10—
American Nuclear Society. Annual Meeting to be held at the Sheraton-Cadillac Hotel, Detroit. Further information can be obtained from the society's Detroit headquarters, 2000 Second Ave., Detroit 26, Mich.

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FOR EVERY APPLICATION

WITH BENDIX-WESTINGHOUSE QUALITY!

Our name plate on *diaphragm* type air cylinders has been a solid guarantee of quality for a long time. Now for the first time we are offering a line of *piston* type air and hydraulic cylinders built to the same high standards.

So, whether you manufacture or use equipment which incorporates power cylinders, Bendix-Westinghouse can now be your source for every requirement. We maintain a sizeable inventory of machined parts to assure fast delivery.

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metal rod scraper
self-adjusting packings
key-type locking ring
360° rotation of ports
variety of mountings
spot-faced mounting holes
full cushioning without length increase
heavy wall precision honed tubing
cartridge-type rod bearing
"O" ring seal between head and cylinder wall
built to J.I.C. standards
standard diameters up to 8"

THESE NEW BENDIX-WESTINGHOUSE CYLINDERS ARE AVAILABLE UP TO 200 PSI AIR AND 1800 PSI HYDRAULIC. WRITE FOR LITERATURE TODAY.

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INDUSTRIAL PRODUCTS

Bendix-Westinghouse Automotive Air Brake Company, Elyria, Ohio

Circle 423 on Page 19

Rockwell-Standard helped make this husky hauler a marvel of maneuverability!

Powerful enough to handle huge payloads . . . yet maneuverable enough to negotiate the narrow tunnels and close quarters of rugged underground mining operations!

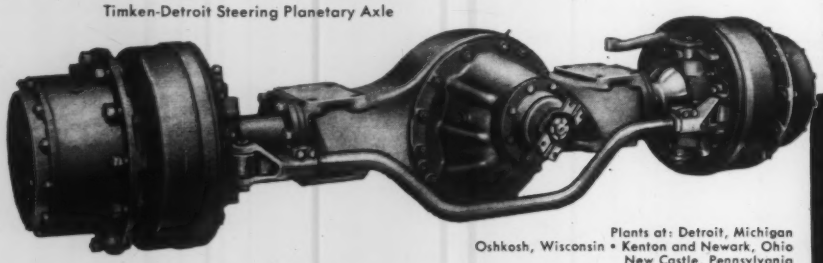
This is the unique combination of qualities required in heavy-duty mine hauling equipment – qualities which the KW-Dart Truck Company *has built* into its new diesel shuttle truck illustrated above.

To help meet these exacting needs, the manufacturer called on Rockwell-Standard—*specialist in planetary-drive axles.* By modifying a pair of its standard steering planetary axles, Rockwell-Standard provided the answer . . . a powerful high-torque driving assembly with four-wheel steering that permits the truck to "crab" and maneuver in and out of tight places.

Rockwell-Standard has more experience than any other axle manufacturer in making dependable planetary-drive axles for every type of heavy-duty off-highway hauling and earth-moving equipment. If you have a problem involving power transmission and propulsion, let Rockwell-Standard engineers help you. They'll give you the solution—at lowest cost.

Timken-Detroit Steering Planetary Axle

©1958, R-S Corp.



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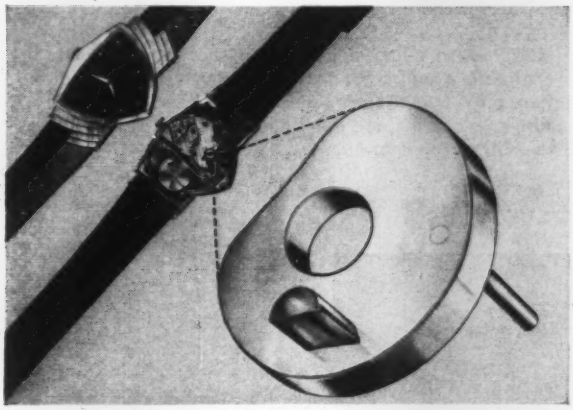
TIMKEN Detroit AXLES
ROCKWELL-STANDARD CORPORATION
TRANSMISSION AND AXLE DIVISION
DETROIT 32, MICHIGAN
Accepted RA Standard

Another Product of **ROCKWELL-STANDARD** Corporation

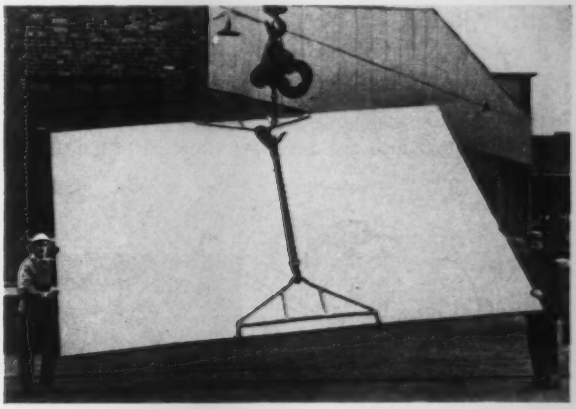
Circle 424 on Page 19

1/7000 OF AN OUNCE or

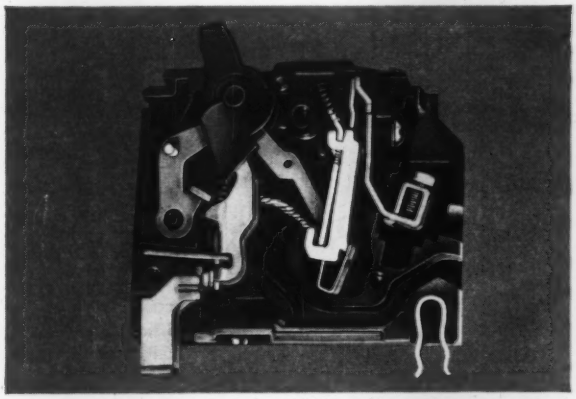
7 tons. In metals, it's the right combination of properties that counts. So just specify the properties you need. You may find the answers from Anaconda very interesting.



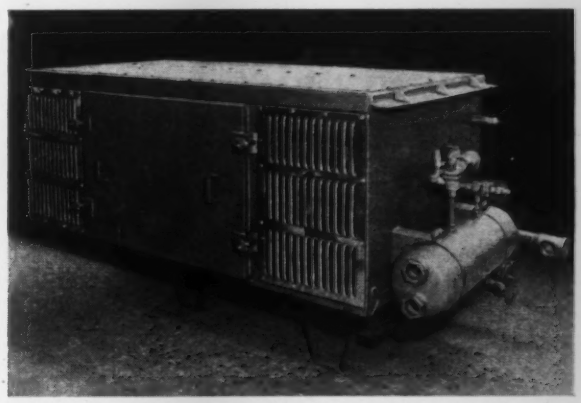
HAMILTON WATCH CO., for the world's first electric wristwatch, demanded these qualities in metal for a vital 1/7000-ounce indexing roller – high hardness and tensile strength; ease of blanking, machining; nonmagnetic properties. Anaconda Ambraloy-901 met the need perfectly. The magnified pinhead-size assembly shown above has a half-round sapphire jewel. The pin limits balance motion.



ALLIS-CHALMERS – building what may be the world's largest surface condenser for Commonwealth Edison Co. – needed tube sheets which combined strength and corrosion resistance with machinability. The answer was Anaconda leaded Muntz metal – 4 plates, each 13' x 17', 1¼" thick, weighing over 7 tons. When drilled, plates support 21,960 tubes, for 200,000 square feet of condensing area.



SQUARE D COMPANY needed low electrical resistance, high spring properties, fatigue resistance in critical parts (in color above) of their QO circuit breaker. Electrical resistance of ordinary phosphor bronzes was too high. So was the cost. Engineers of The American Brass Company suggested Anaconda Ambronze-474 and Square D found it had the right combination of properties for the need. And this metal provided superior forming and lower material costs.



THE TRANE COMPANY'S railroad air-conditioning "dry-wet" combination condensers are mounted under cars – facing severe corrosive conditions and a beating from roadbed gravel and stone. Exposed metal, including casing, liquid receiver, 170-gal. water tank, must have superior corrosion resistance, high strength and toughness. Trane has found Everdur®, Anaconda's group of copper silicon alloys, meets its needs. And Everdur is easy to fabricate.

Starting with 93 standard alloys, The American Brass Company can make minor variations in composition, fabrication, and annealing to provide an almost unlimited number of combinations of useful properties. When new or unusual problems rise, ask for the help of the Technical Dept. in selecting the right metal. For such help or a copy of Publication B-32, "Anaconda Copper & Copper Alloys," write: The American Brass Company, Waterbury 20, Conn. 5854

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COPPER · BRASS · BRONZE · NICKEL SILVER MILL PRODUCTS

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Circle 425 on Page 19

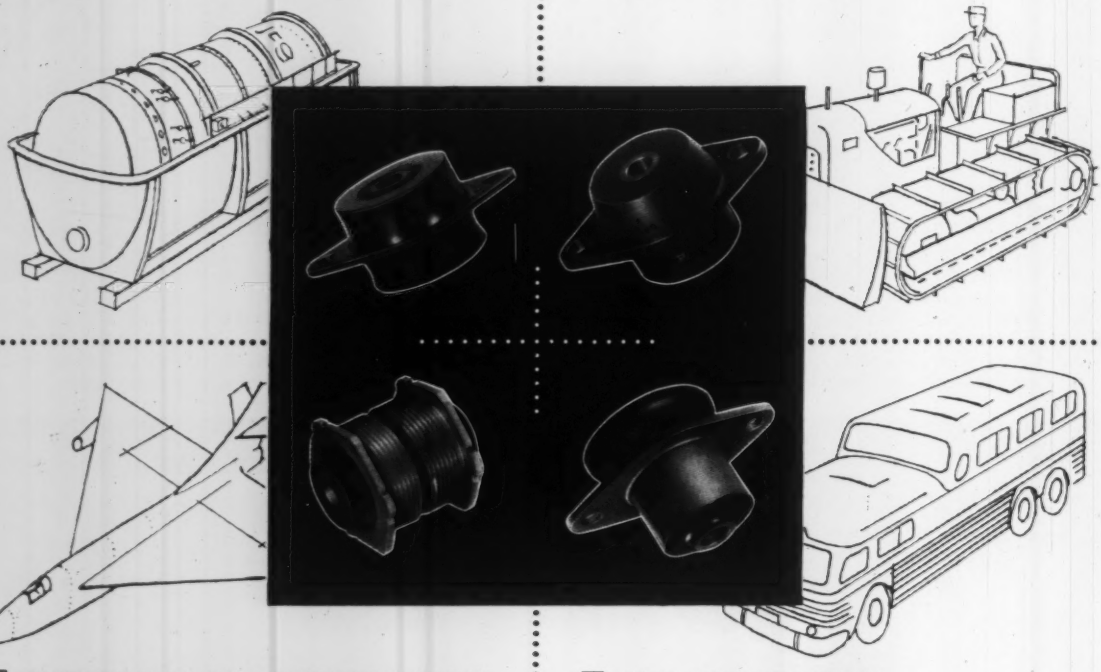
Have you vibration control problems like these?

☐ **SOFTEN TRANSPORTATION SHOCK**

MB Type 1812D83 mounts protect engines in shipping cans. Even for a 3-ft. drop, they restrain displacement and maximum "g" to which engine could be subjected. They also provide a natural frequency to the mass that avoids resonance and amplified vibration in transit.

☐ **ISOLATE RUGGED RIGS**

MB Type 5 mounts stand up and successfully isolate engines of even tractor dozers. The tough service conditions prove the efficiency of this original mount designed with equal spring rate in all directions, and with ability to snub damaging overloads.



☐ **CONTROL OVER FULL FREQUENCY RANGE**

MB ISO-DAMP*mounts do what a conventional isolator cannot. They isolate at both low and high frequencies. Protecting the precision of airborne sighting mechanisms, they not only have the required softness, but also a damping mechanism that restricts resonant build-up to under 3.5 to 1 in any direction. *T.M.

☐ **MORE MOUNT MILEAGE**

MB ISOMODE® mounts break endurance records. Despite heat, road shock and hard operating conditions in bus service, engine mounts removed for critical inspection after 132,000 miles were still good. To such durability add the superior vibration isolation afforded by a mount that controls vibratory motion in all directions.

MB concentrates on standard mounts which are actually in the special performance class. If you have a problem, avail yourself of our 20 years of experience. Send for Bulletin 616A which tells more.

MB manufacturing company 1056 State Street New Haven 11, Conn.

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HEADQUARTERS FOR PRODUCTS TO ISOLATE VIBRATION...TO EXCITE IT...TO MEASURE IT.

Circle 426 on Page 19

EATON-RELIANCE cost-reducing fasteners do the job easier, faster, surer

When you choose industrial fasteners for any type job, you look first for two things—QUALITY and PRICE. Eaton fasteners give you both. Eaton quality is the result of many years' experience, high engineering standards and an efficient quality control system. Eaton also gives you production and service geared to your schedules. The Eaton price is low—consistent with high quality—because machinery is modern, employees are skilled, and the raw steel is cold drawn, cold rolled and heat treated to rigid specifications.

Eaton-Reliance Industrial Fasteners are truly fasteners to be relied on. Design and industrial engineers in major fast-moving industries such as automotive, farm implement, construction machinery, appliance —to mention a few—call for Eaton quality fasteners on many varied types of assemblies.

An examination of our complete line, described in Engineering Bulletin 4K/3, will show you the wide range of types available and give you fresh ideas on cutting your fastener costs; send for a copy today, or request one of our industrial fastener engineers to call. There is no obligation.

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Circle 427 on Page 19

WHAT MATERIAL

DRY CHOCOLATE DISPENSER. To meet special qualities in esthetics and strength, BAKELITE TMDB-5161 is used in molding the precision main parts of the new "Carnation" hot cocoa mix dispensers for use in the restaurant field. The high heat-and-impact resistance of this styrene material makes it completely washable, and insures accurate, trouble-free service.

Molded by Field Manufacturing Corp., Santa Monica, Calif.

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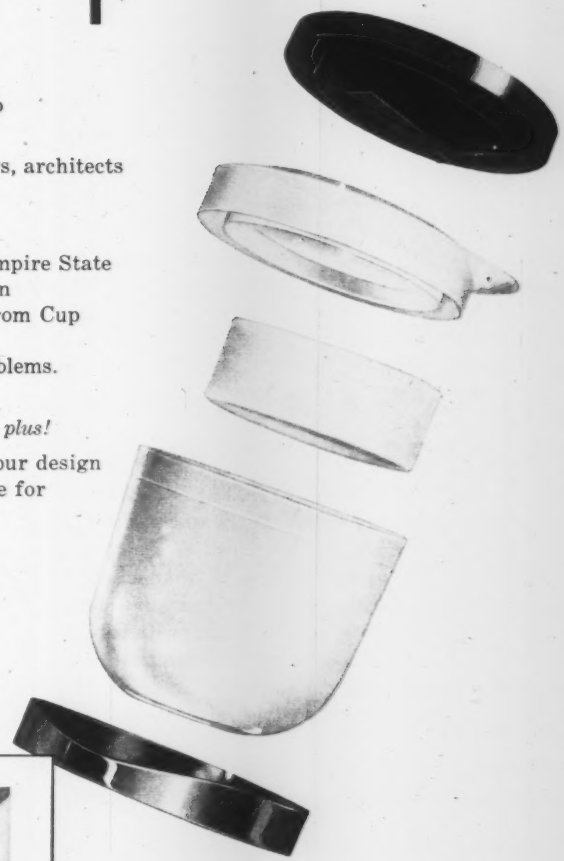
PLASTICS

. . . offering new freedom in design . . . and cost . . . and functional advantages!



It continually appears in *new* compounds and forms to meet new specifications.

It encourages the creative talents of design engineers, architects and interior and industrial designers.

You *know* the answer—*BAKELITE* Brand *Plastics.*

From the coatings on TV towers atop New York's Empire State Building to undersea oil rigs . . . from the packages on supermarket shelves to molded appliance parts . . . from Cup challenger yacht hull sealers to jet plane controls . . . *BAKELITE* Brand *Plastics* are solving new design problems.

And *BAKELITE* Brand *Plastics* almost invariably offer cost, production and functional advantages *as a plus!*

BAKELITE COMPANY WILL HELP YOU: Whatever your design area, no matter how unusual the qualities you require for forming, strength, rigidity, flexibility, insulation, corrosion resistance—explore the proven advantages of *BAKELITE* Brand *Plastics* and *Resins.* The material that's new all the time!

Technical representatives with years of training and field experience are available to discuss vour special design problems. Write Dept. JW-51-D.

THIS NEW AND DIFFERENT BLENDER, with separate compartments from which liquids are automatically mixed when poured, is easy to clean and hard to break. BAKELITE C-11 acrylonitrile-styrene-copolymer is used for the outer container, for strength, chemical resistance and low cost. The lid is BAKELITE Brand Styrene Plastic. Molded by Avsco, Inc., Excelsior Springs, Missouri.

Products of UNION CARBIDE *Corporation*

BAKELITE COMPANY, *Division of Union Carbide Corporation,* 30 East 42nd Street, New York 17, N. Y.

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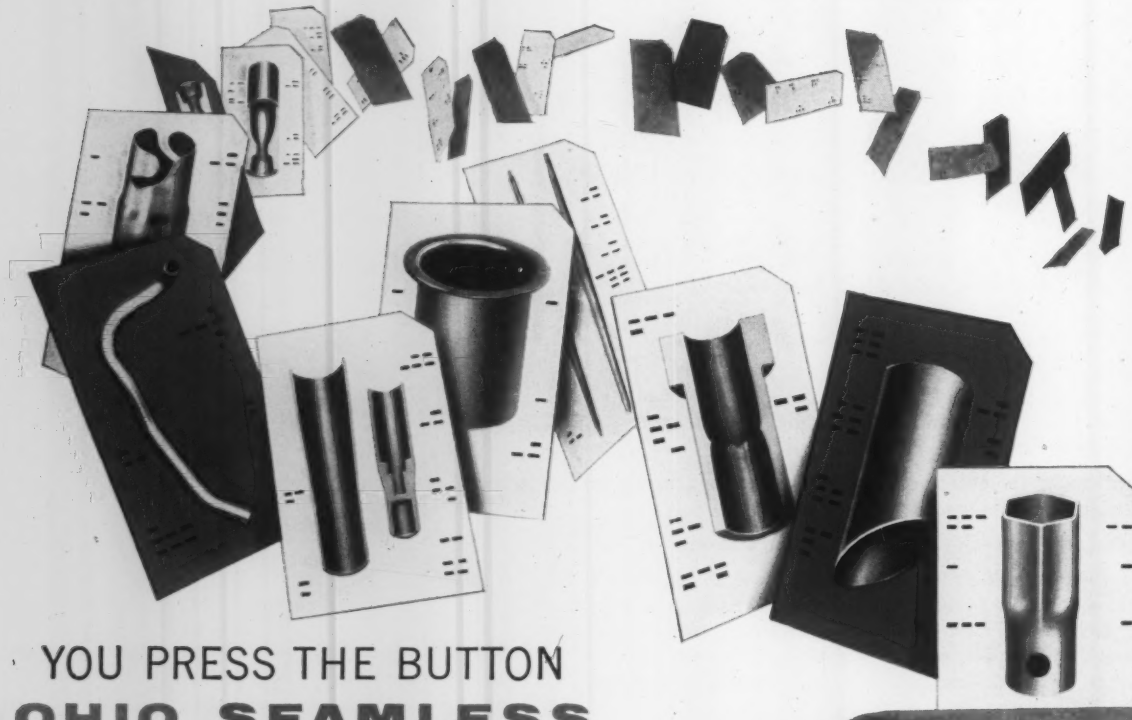
When you buy from Ohio Seamless



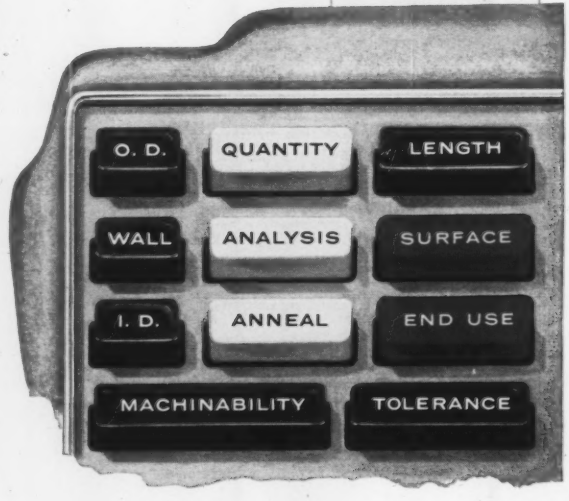
YOU PRESS THE BUTTON
OHIO SEAMLESS
DOES THE REST

Buying steel tubing from Ohio Seamless doesn't cost—it *pays*. Our minimum quantities are generally smaller than you may realize . . . often as small as 100 to 150 feet, in certain seamless grades and sizes.

When you buy from us, you're dealing with tubing *experts* . . . men who can recommend the *exact* Ostuco Tubing to suit your product and processes. There's no compromise on analysis, size, anneal, etc.

Advantages of buying from Ohio Seamless multiply, the closer you examine them. Our single-source service eliminates headaches of interplant shipments . . . possible errors . . . multiple purchase orders and invoices. Ohio Seamless keeps your production lines humming because you get *precisely what you want.*

For proof, contact our nearest sales office or the plant at *Shelby, Ohio—Birthplace of the Seamless Steel Tube Industry in America.* AA-7116



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Circle 429 on Page 19

Air seals
Bearing seals
Cable wrapping
Carburetor diaphragms
Carrying cases
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Fuel containers
Fuel pump diaphragms
Gaskets
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. . . the one complete source of engineered industrial coated fabrics

Whether it's resistance to high temperature, oil or abrasion—or flexibility at low temperature or room temperature, there's a Reevecote designed to do your job.

96 different Reevecote styles are in stock at all times! Constructed under rigid quality-control standards, each is guaranteed to meet the exact listed specifications.

In addition, full research and development facilities are available for new applications, backed by the skills and knowledge of fabrics and coatings that only the combination of Reeves and Vulcan can supply. Whatever your requirements, specify Reevecote and be sure.

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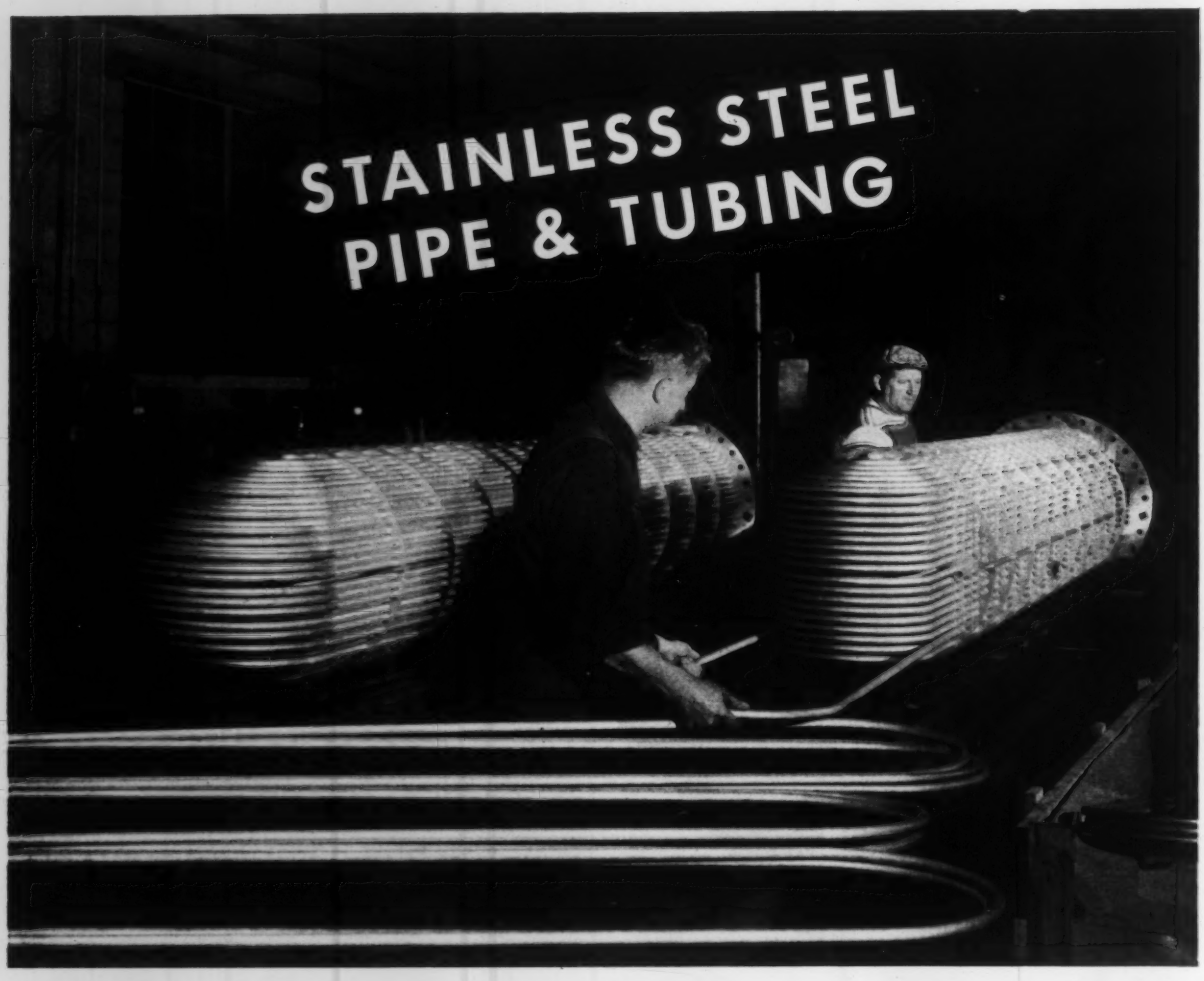
CITY_____STATE_____

Circle 430 on Page 19



ODDS AGAINST LEAKERS · · · 3400 TO 1

The percentage is all in your favor when you use Damascus tubing. Customer claims entered for settlement over a 5-year period amounted to only 3/100 of 1% of all tubing shipped. A remarkable record—one that can save you time and money. On new equipment or when you are re-tubing, always specify Damascus. Available in stainless for normal corrosive service . . . and in reactive metals and super-alloys for special applications.

U-TUBES OR SPECIAL BENDING — Damascus is also able to supply U-tubes fabricated to your specifications, as well as precision coiling and custom bending. For additional information, write or call.

COMPLETE INFORMATION on RARE and REACTIVE METALS PIPE and TUBING

New 44-page handbook contains data on applications, heat treatment, corrosion resistance, chemical and physical analysis, mechanical properties of Zirconium, Zircaloy 2, Zircaloy 3; Titanium, grades 40, 55, and 70; Precipitation Hardening Steels, A-286, 17-7-PH, 15-7-MO; Hastelloys A, B, C, F, and X.

AMERICAN STEEL WAREHOUSE ASS'N

DAMASCUS TUBE COMPANY

STAINLESS STEEL TUBING AND PIPE

GREENVILLE, PENNSYLVANIA

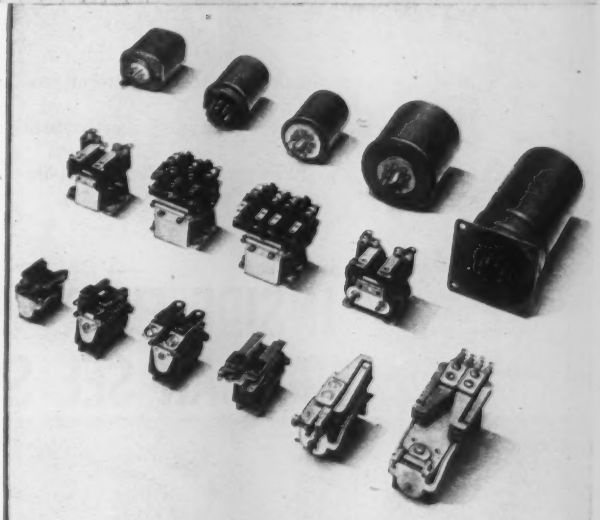
FORMED STEEL TUBE INSTITUTE

Circle 431 on Page 19

RELIABILITY WITH OHMITE® RELAYS

65 Types in four stock models mean industrial sales for you. Models DOS, DOSY, DO, and CRU are available. Models DO and DOS fill many industrial needs for a compact, lightweight relay that handles power loads usually requiring much larger, heavier units. The increased operating sensitivity of Model DOSY relay, equipped with twin coils, makes it adaptable to a wide range of electronic control circuits, such as plate circuit controls. Model CRU is outstanding for its wide range of available contact combinations, its small size, and rugged constitution. At 115 vac or 32 vdc, noninductive load, Models DOS and DOSY have contact ratings of 15 amp; Model DO, 10 amp; and Model CRU, 5 amp. Available in a wide range of coil operating voltages and contact combinations.

Write on company letterhead for Catalog 58.



TWO NEW OHMITE RELAYS

- with exclusive "Molded Module"* contact springs
- exceptional sensitivity for small size
- designed to meet aircraft, military, and industrial applications

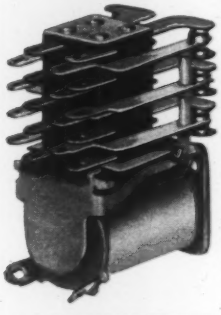
*patent applied for

The new Models TT and TS relays are lightweight, yet rugged. Paramount among the design innovations is the revolutionary "Molded Module" contact spring construction. The "module" is a standard, single-pole, double-throw, spring combination molded into a single compact assembly. As many as six modules can be incorporated into a relay to provide a maximum six-pole, double-throw combination. With the springs rigidly held in a matrix of tough plastic, alignment of the springs is assured. More accurate alignment of all the subcombinations (modules) on the relay is possible, and adjustment of the individual contact springs is easier and more permanent. Diall Phthallate, the molding material, is capable of withstanding temperatures to 400°F.

A contributing factor to the remarkable sensitivity of these relays is the design of the armature retaining guard to minimize undesirable heel gap. A wide variety of hermetically sealed enclosures is available.

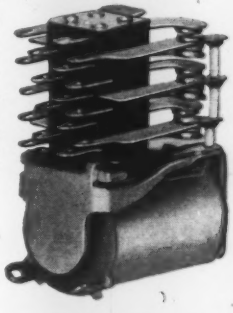
Model TT

Molded Module

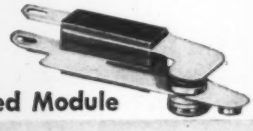


Coil Wattage: rated nominally at .150 watt per pole at an ambient temperature of +20°C; Coil Operating Voltage Range: to 115 vdc; Contact Ratings: up to 5 amperes at 115 volts ac or 32 volts dc noninductive, with standard contact material, palladium. Other materials can be supplied; Contact Combinations: standard combinations are dpdt, 4pdt, and 6pdt (maximum). Others can be furnished. Weight: approximately 2 ounces for 4 pdt relay.

Model TS



Coil Wattage: rated nominally at .250 watt per pole at an ambient temperature of +20°C; Coil Operating Voltage Range: to 115 vdc; Contact Ratings: up to 10 amperes at 115 volts ac or 32 volts dc noninductive with standard contact material, silver-cadmium oxide. Other materials can be supplied; Contact Combinations: standard combinations are dpdt, 4pdt, and 6pdt (maximum). Others can be furnished. Weight: approximately 3 ounces for 4pdt relay.



Molded Module

RHEOSTATS RESISTORS RELAYS
TAP SWITCHES TANTALUM CAPACITORS
R. F. CHOKES VARIABLE TRANSFORMERS

Be Right with OHMITE® QUALITY Components

OHMITE MANUFACTURING CO.
3618 Howard Street, Skokie, Illinois

TYPICAL SCHRADER SIMPLIFIED VALVE DESIGN

. . . another reason why your air system installations will perform best.

A—Mounting holes always conveniently located.

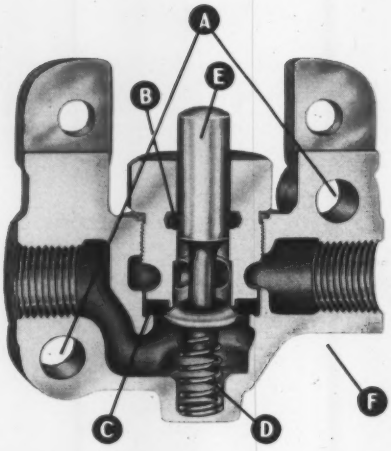
B—"O" rings used for surest airtight seal.

C—Oil-resistant synthetic rubber used in washers for positive leakproof seat.

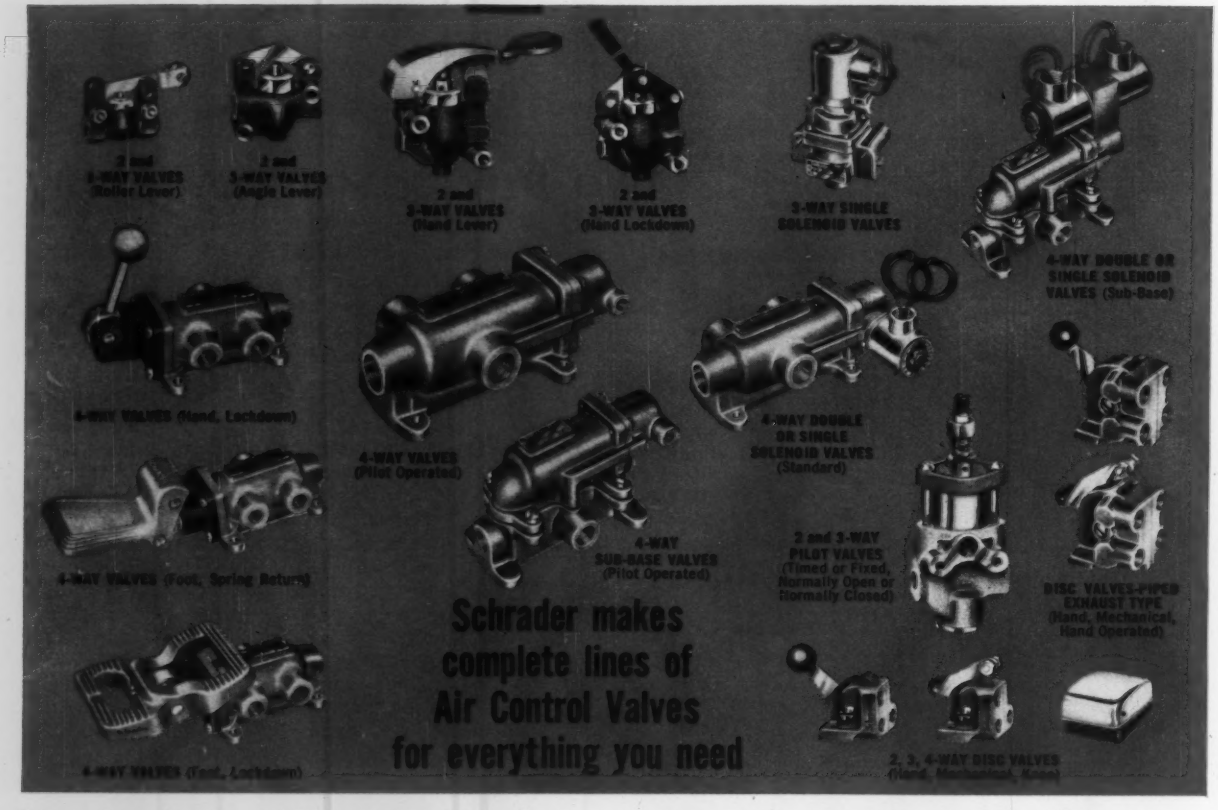
D—Stainless steel springs: rust resistance, longest service life.

E—Sturdy plated plungers, quick acting, smooth-operating.

F—All parts designed for greatest air flow, longest life and simplicity of replacement and interchangeability.



INSIDE EVERY SCHRADER VALVE YOU CAN SEE SCHRADER QUALITY


2 and 3-WAY VALVES (Roller Lever)
2 and 3-WAY VALVES (Angle Lever)
2 and 3-WAY VALVES (Hand Lever)
2 and 3-WAY VALVES (Hand Lockdown)
2-WAY SINGLE SOLENOID VALVES
4-WAY DOUBLE OR SINGLE SOLENOID VALVES (Sub-Base)
4-WAY VALVES (Hand, Lockdown)
4-WAY VALVES (Pilot Operated)
4-WAY DOUBLE OR SINGLE SOLENOID VALVES (Standard)
4-WAY VALVES (Foot, Spring Return)
4-WAY SUB-BASE VALVES (Pilot Operated)
2 and 3-WAY PILOT VALVES (Timed or Fixed, Normally Open or Normally Closed)
DISC VALVES-PIPED EXHAUST TYPE (Hand, Mechanical, Hand Operated)
4-WAY VALVES (Foot, Lockdown)
2, 3, 4-WAY DISC VALVES
Schrader makes complete lines of Air Control Valves for everything you need

Plus hundreds of Air Cylinders and accessories for every need

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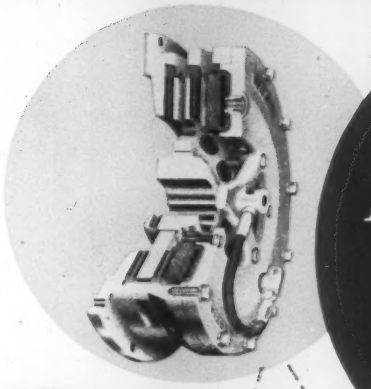
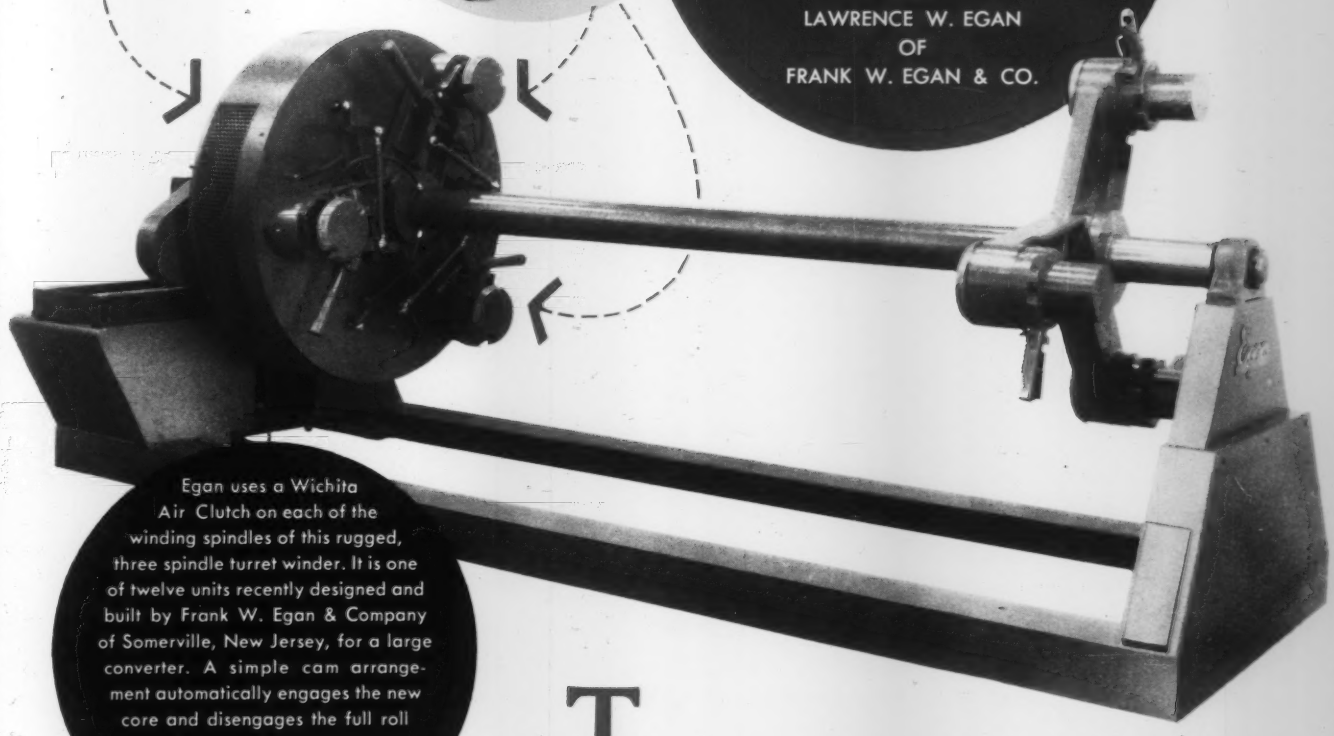
476 Vanderbilt Avenue, Brooklyn 38, N. Y.

QUALITY AIR CONTROL PRODUCTS



"Wichita Clutches are highly **DEPENDABLE** *on our automatic winders,"*

SAYS
LAWRENCE W. EGAN
OF
FRANK W. EGAN & CO.



Egan uses a Wichita Air Clutch on each of the winding spindles of this rugged, three spindle turret winder. It is one of twelve units recently designed and built by Frank W. Egan & Company of Somerville, New Jersey, for a large converter. A simple cam arrangement automatically engages the new core and disengages the full roll as the turret is rotated into transfer position.

Wichita Low Inertia Air-Tube Disc Clutch

These Wichita-equipped winders are designed to handle a wide range of webs.

"Since our winders are designed to accommodate various webs," says Mr. Egan, "we require a highly dependable clutch which can be maintained easily and does not involve complex linkages to obtain necessary automatic features. The design of the Wichita Clutch also lends itself to a more compact assembly."

If you want the best service from your equipment, be sure it is equipped with Wichita Air Clutches and Brakes.

Contact your nearest Wichita Engineer!

Brehm-Lahner, Inc., Detroit, Michigan
L. H. Fremont, Cincinnati, Ohio
W. G. Kerr Company, Pittsburgh, Pa.
Smith-Keser & Co., Avon, Conn., Philadelphia 44, Pa., and New York, N. Y.
Frank W. Yarline Co., Chicago, Illinois
Larry W. McDowell, Long Beach, California
Andrew T. Lobel, Denver, Colorado
Robert R. King Co., Cleveland, Ohio
Norman Williams, Houston, Texas
Allied Transmission Equipment Co., Kansas City 8, Missouri
Donald E. Harman, Dallas, Texas
C. Arthur Weaver, Richmond, Virginia
Malcolm S. Cone, Memphis, Tennessee
Dominion Power Press Equipment, Ltd., Burlington, Ontario, Canada
R. E. Kunz, Seattle 4, Wash.
W. G. Ballantyne Co., Portland 4, Ore.
Bates Sales Co., St. Louis 1, Mo.

WICHITA Clutch COMPANY, INC.
WICHITA FALLS, TEXAS, U.S.A.

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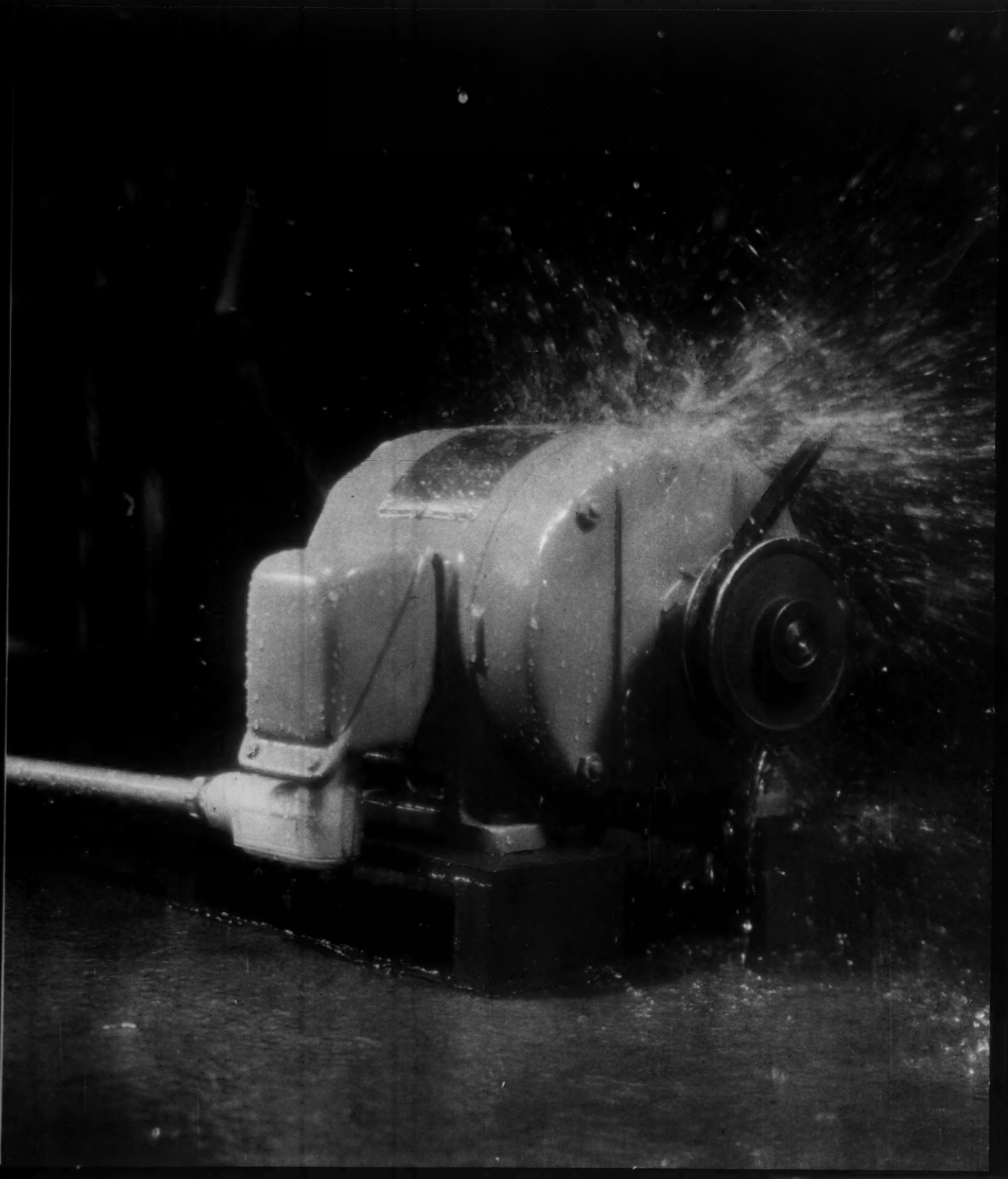
Circle 435 on Page 19

Get dependable operation, increased



quality for your product . . .

GENERAL ELECTRIC TRI 55 CLAD MOTORS PROVE THEY PROVIDE IT BY PASSING TORTURE TEST

HERE'S HOW: G-E Tri/Clad '55' polyphase motors are more fully enclosed than ordinary dripproof motors. This extra protection makes them suitable for many jobs which normally require splashproof motors . . . extra protection at no extra cost.

Mylar* polyester film slot and phase insulation, non-wicking leads, and water-resistant stator coating give long-life protection against *moisture*. Formex† magnet wire provides protection against heat-aging and *dirt*. Heavy-duty bearing system keeps lubricant in, abrasive dust out. And rigid cast-iron frame and endshields and melamine paint finish protect G-E motors against *external damage*.

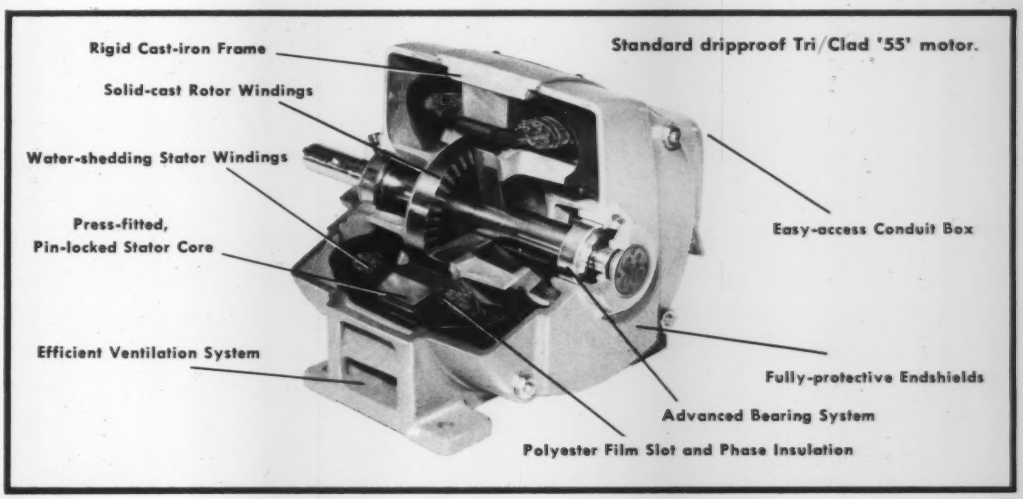
*Registered Trade-mark of DuPont Co.

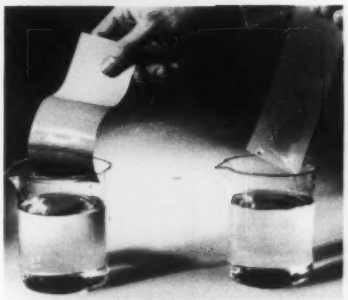
These are just some of the outstanding Tri/Clad '55' motor features which mean longer life, more dependable operation—improve the quality and saleability of your product at no extra cost to you *or* your customers!

CONTACT your nearest G-E Apparatus Sales Office for *personal proof* on how G-E Tri/Clad '55' motors can give better operating protection to your products. And ask for your free copy of descriptive bulletins, GEA-5980 and GEA-6602, or write to Section 840-19, General Electric Company, Schenectady 5, New York.

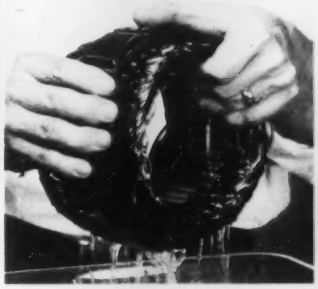
†Registered Trade-mark of General Electric Co.

GENERAL ELECTRIC

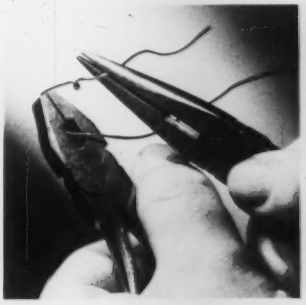




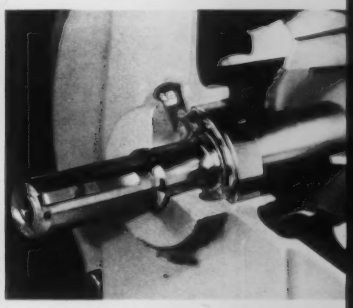
Mylar Insulation protects against moisture; assures longer motor life, minimum maintenance.



Water-resistant Coating applied to every stator assembly virtually eliminates insulation failure due to moisture.

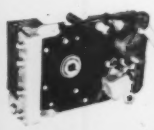


Formex Wire insulation will not break under severe conditions—protects against heat-aging and abrasive dust.



Long-life Bearing System seals dirt out, has new longer-lasting grease, can be regreased.

Hummingbirds Are Power-Packed...have more energy for their size than an elephant. Smallest hummingbird is only 2⅜" long, builds a nest only 1" square with cobwebs. The hummingbird is one of nature's greatest masterpieces in miniaturization.



Miniature Tape Recorder fits in briefcase . . . operates on hearing-aid batteries yielding 1/8000 h.p. This is possible because friction is reduced by two MPB bearings installed on the main drive shaft. Another man-miracle in the world of miniaturization.

Man With Miracles. This is Bill Timmerman, one of MPB's Sales Engineers. He helped the tape recorder people find exactly the right type of bearing to reduce friction to a minimum, give failure-proof service and help keep original and maintenance costs low.

More Miracles in Miniaturization to come

BEARING ACTUAL SIZE

It's just starting. Industry is on the threshold of new miracles in the world of miniature mechanisms. Best help in the problems will be MPB who has the world's greatest wealth of experience in the application of miniature bearings ⅜" O.D. or less. MPB has more than 500 types and sizes, specials on request, engineering and research facilities second to none. You'll want to know more about miniaturization and the promise of progress it holds. For engineering aid and/or new catalog write **Miniature Precision Bearings, Inc.,** 110 Precision Park, Keene, N. H.

MPB

Helps you perform miracles in miniaturization

Circle 436 on Page 19

WELD ANYWHERE

with the new Aircomatic® MIGet

(pronounced "midget")

The lightweight, versatile Aircomatic MIGet, for gas-shielded arc welding, operates 50 ft. from control panel, with control panel 100 yds. from power supply!

The MIGet carries its own drive rolls and one-pound reel of .030", .035", 3/64" or 1/16" aluminum wire; or two-pound reel of .030", .035" or .045" hard wire. Feed speed to 900 inches per minute . . . 200 amperes. DC. Air cooled. Gun, without reel, weighs about three pounds. Control cabinet, 17 pounds. Here is *THE* gun for short-length welds in hard-to-get-at places.

Send today for technical literature on the Aircomatic MIGet. Or phone your nearby Air Reduction Sales Office.

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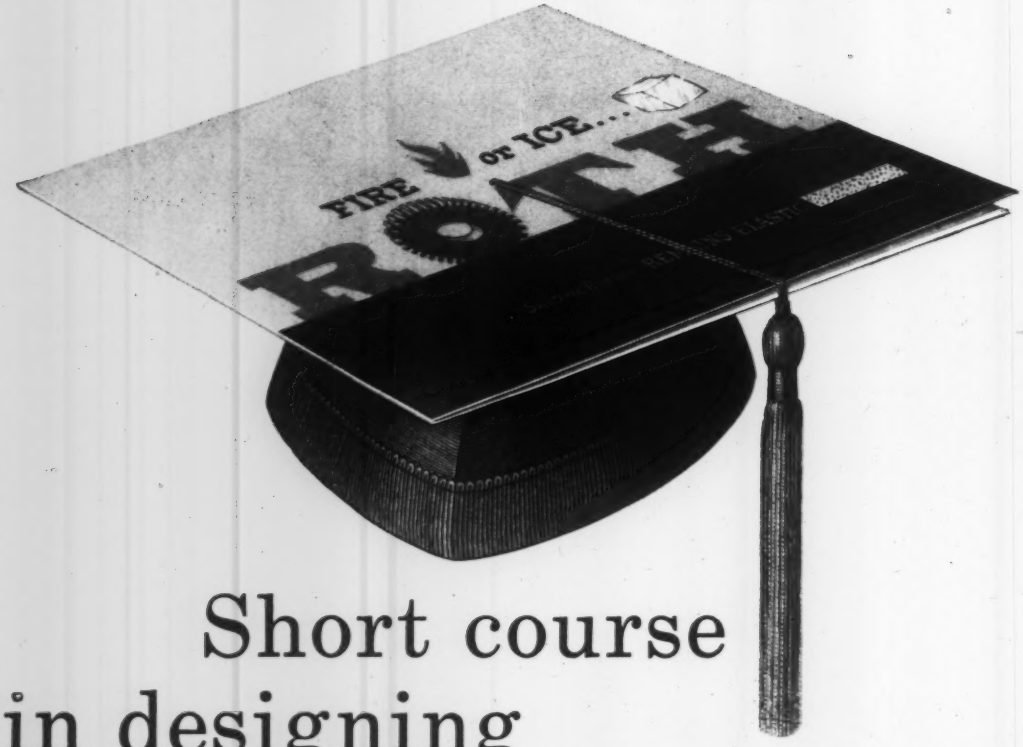
AT THE FRONTIERS OF PROGRESS YOU'LL FIND AN AIR REDUCTION PRODUCT • Products of the divisions of Air Reduction Company, Incorporated, include: **AIRCO** – Industrial gases, welding and cutting equipment • **AIRCO CHEMICAL** – vinyl acetate monomer, vinyl stearate, methyl butynol, methyl pentynol, and other acetylenic chemicals • **PURECO**–carbon dioxide–gaseous, welding grade CO_2, liquid, solid ("DRY-ICE") • **OHIO**–medical gases and hospital equipment • **NATIONAL CARBIDE**–pipeline acetylene and calcium carbide • **COLTON**–polyvinyl acetate, alcohols, and other synthetic resins.

Circle 437 on Page 19



Short course in designing products that win sales honors

You're looking at a brand-new booklet that can mean longer service life, greater dependability, new applications, and new markets for your products. It gives the facts on the unusual properties of Roth Silicone Rubber . . . tells how Roth Silicone can stand up under an extreme range of temperatures, retain its conformity under compression, shrug off solvents, and resist weather, oil, and high-voltage corona. There's more, too . . . much more. Here's the full story on Roth Silicone Rubber Sheeting, both sponge and solid, and Roth Molded Silicone Rubber Parts . . . helpful details on their physical properties . . . down-to-earth reasons why Roth Silicones can cut production costs, simplify product design, and enable you to sell markets you couldn't touch before. Write for your copy of "Fire or Ice" today.

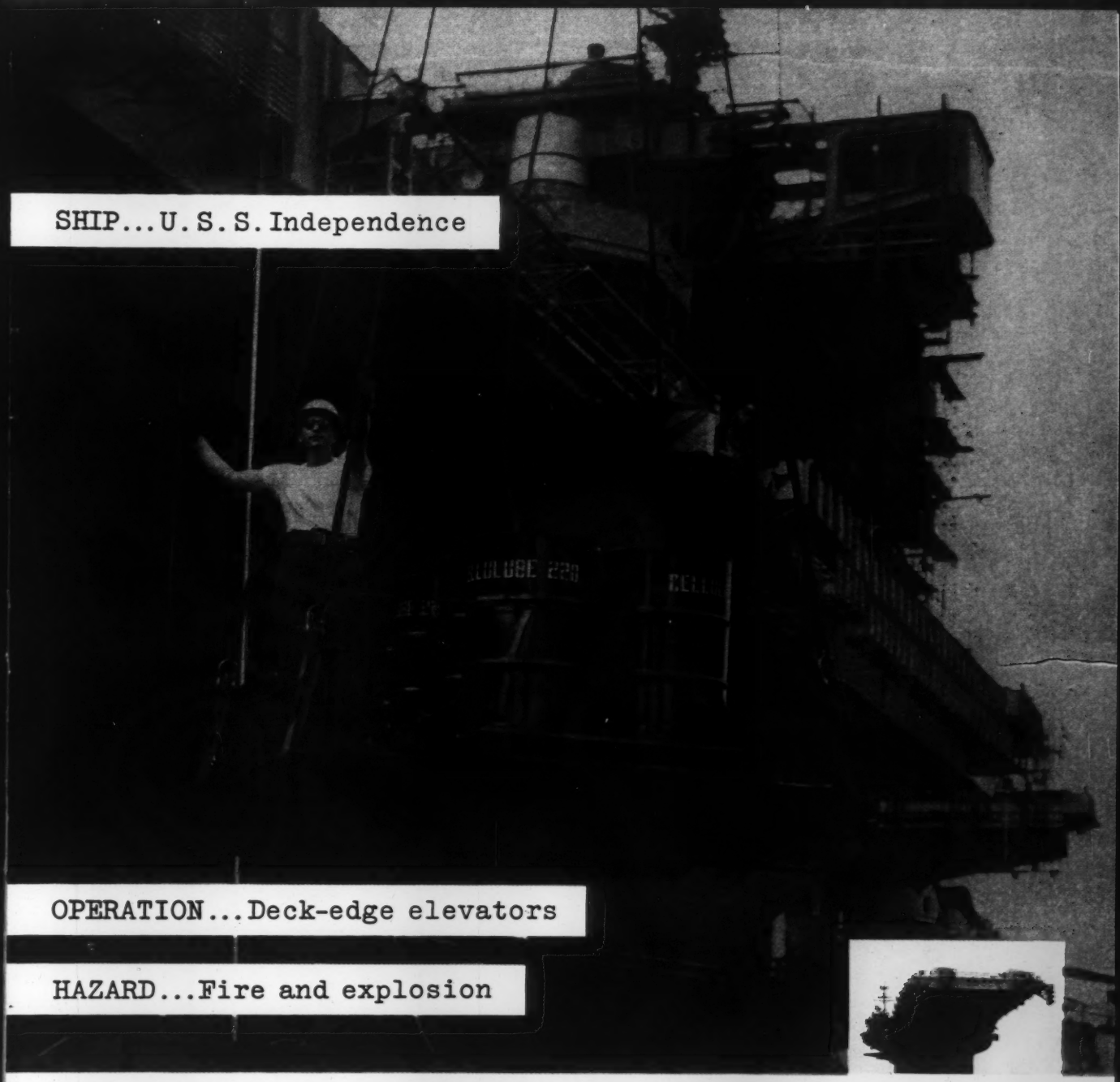
ROTH

RUBBER COMPANY

1860 S. 54th Ave., Chicago 50, Ill.

DIVISION OF VAPOR HEATING CORPORATION

Circle 438 on Page 19



Hydraulic Fluid Used...FIRE-RESISTANT CELLULUBES

Fifty-five gallon drums of Cellulube . . . part of a six-car train load . . . being put aboard the Independence to operate deck-edge elevators between hangar and flight decks.

The U. S. S. Independence, newest Navy supercarrier, recently christened and soon to be commissioned.

Thousands of gallons of Celanese Cellulubes . . . fire-resistant hydraulic fluids . . . have been loaded aboard the U.S.S. Independence, the Navy's newest 60,000-ton supercarrier. In fact, *all* of the ships in the Navy's great carrier fleet carry Cellulubes in the hydraulic systems of their deck-edge elevators . . . and on the mighty missile ships, atomic-powered submarine and destroyers, too, these functional fluids are doing their fire-safe hydraulic duty.

The Navy has long used Cellulubes, and industry, too, of course, has long depended on these outstanding hydraulic fluids . . . for power transfer and lubrication where sure resistance to flame and explosion, excellent lubricity, and unchanging viscosity are important. Cellulubes are available in six controlled viscosities, one of which is best suited to your particular operations and the safety of your plant. For evaluation samples, please let us know the application involved. Celanese Corporation of America, Chemical Division, Dept. 545-J, 180 Madison Avenue, New York 16, N. Y.

Celanese® Cellulube®

Cellulubes... Celanese CHEMICALS fire-resistant functional fluids

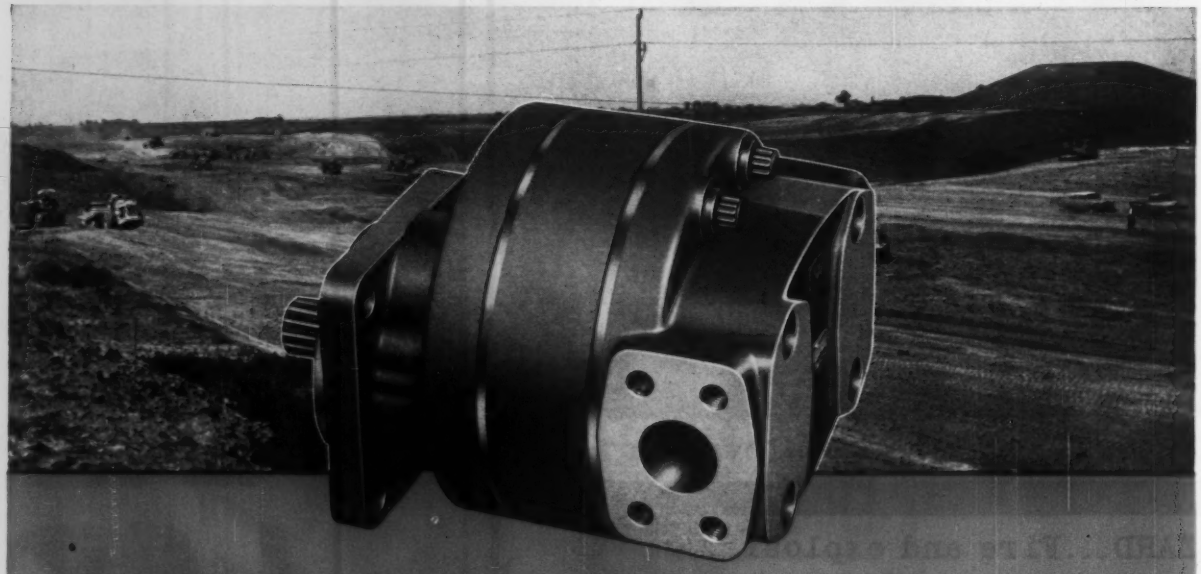
Canadian Affiliate: Canadian Chemical Co., Limited, Montreal, Toronto and Vancouver • Export Sales: Amcel Co., Inc., and Pan Amcel Co., Inc., 180 Madison Avenue, New York 16, N.Y.

Circle 439 on Page 19

capacity for Big payloads

Now you can have all the advantages of Webster pumps in capacities up to 124 gpm. New "HF" series are high capacity, gear-type pumps especially designed for heavy earth moving and construction equipment. Built to perform under heavy shock loads, long continuous operation. The "HF" series is available in 5 sizes, with capacities from 18 to 124 gpm, operating pressures up to 1500 psi and operating speeds to 2400 rpm. Like all Webster hydraulic pumps, the new big capacity series is compact for easy adaptation to your product . . . operate at maximum efficiency on low power requirements.

NEW Webster "HF" SERIES HYDRAULIC PUMPS



These Webster features mean QUALITY!

1. Integral drive, idler shaft and gear assembly.
2. High capacity roller bearings at all four bearing points.
3. Ball bearing to absorb end thrust.
4. Internal splined shaft (no keying problems).

WRITE for facts, figures and data on the new Webster "HF" series pumps.

Call the man from Webster

OIL HYDRAULICS DIVISION

WEBSTER ELECTRIC

RACINE · WIS

CAPACITY RANGE OF "HF" SERIES PUMPS

Ratings shown are tentative standards which may be changed to meet your own requirements.

MODEL	GEAR WIDTH, INCHES	DISPLACE. CU. IN. PER REVOLUTION	GPM @ 1200 RPM & 1000 PSI	GPM @ 1800 RPM & 1000 PSI	GPM @ 2400 RPM & 1000 PSI
10 HFS	1	4.3	18	30	41
15 HFS	1½	6.5	28	45	61
20 HFS	2	8.6	38	60	83
25 HFS	2½	10.8	52	76	112
30 HFS	3	13.0	59	92	124

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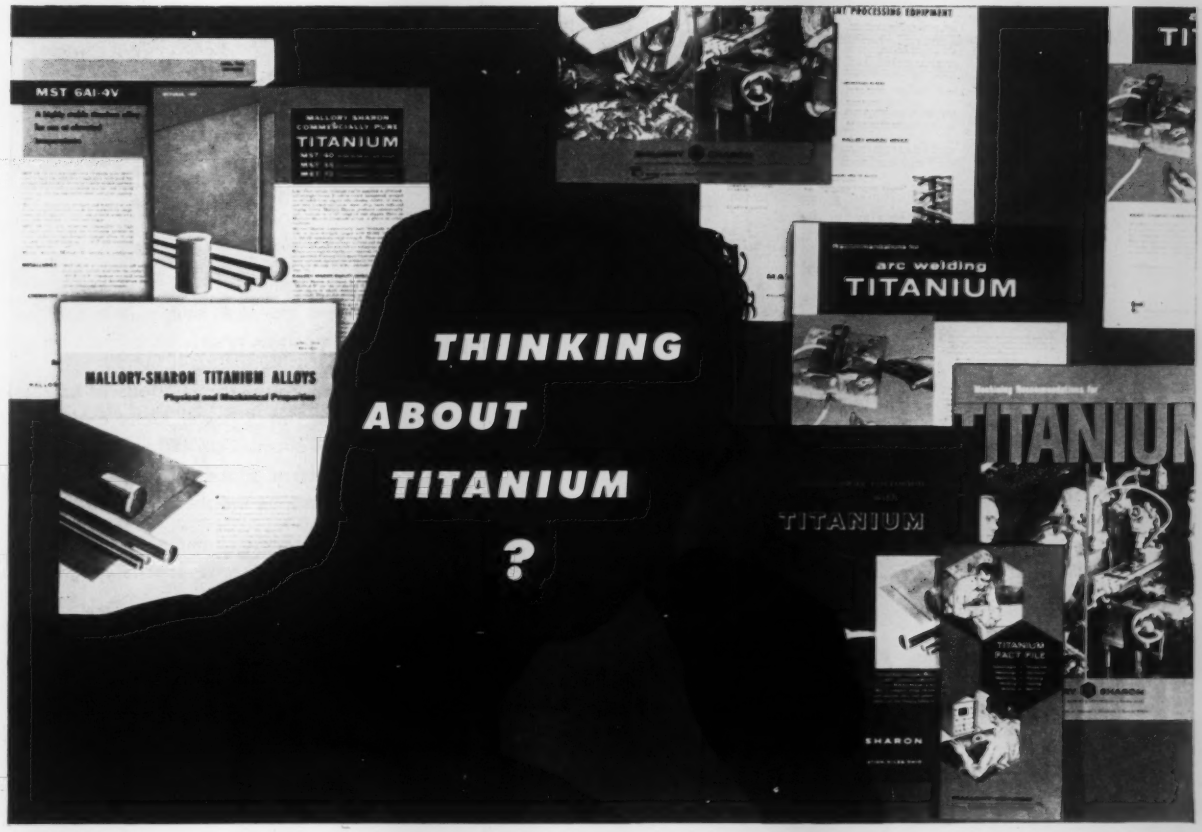
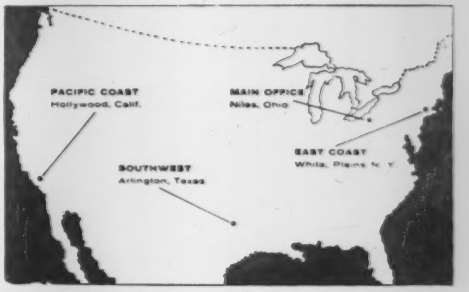


Help yourself to this helpful data

Mallory-Sharon, as a pioneer in titanium technology and largest integrated producer of special metals, offers you a wealth of technical assistance . . . both in print and in person.

Technical bulletins on titanium's properties and advantages are available through Mallory-Sharon headquarters or sales offices. They're yours for the asking. Use coupon below.

On special problems or applications, our experienced Service Engineering group is ready to work with you. To make use of this application service, just phone or write your nearest Mallory-Sharon sales office.



Mallory-Sharon Sales Offices *are strategically located throughout the U.S.A. We'll gladly send you the name of our representative in office nearest you.*

MALLORY MS **SHARON**

MALLORY-SHARON METALS CORPORATION · NILES, OHIO

- ☐ Arc Welding Titanium
- ☐ Machining Recommendations for Titanium
- ☐ Titanium Alloys: Physical and mechanical properties
- ☐ MST 6AI-4V Titanium Alloy
- ☐ Commercially Pure Titanium
- ☐ Corrosion Properties of Titanium
- ☐ Titanium Fact File

Mallory-Sharon Metals Corporation
Niles, Ohio

Please send me the technical bulletins on titanium checked at left.

Name_____

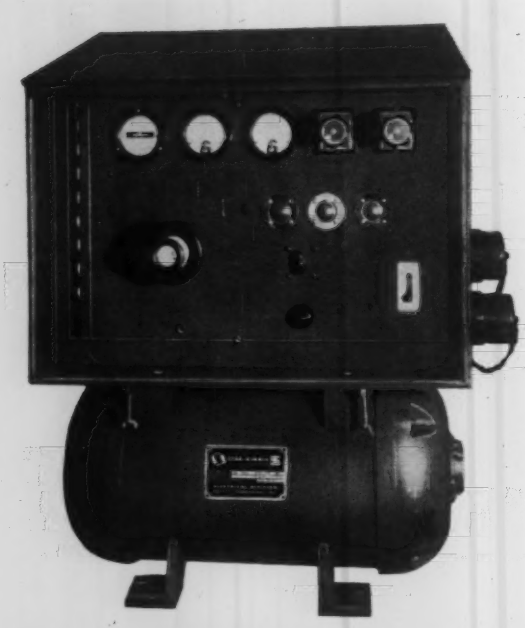
Title_____

Company_____

Address_____

City & State_____

Circle 441 on Page 19



New "400"-Cycle POWER PACKAGE!

UNIT-MOUNTED

- **Motor**
- **Inductor-Alternator**
- **Regulation**

Motor-Generator Sets by

STAR-KIMBLE

Circle 442 on Page 19

THE PACKAGE:

- *A single compact unit.* Motor, alternator and controls built in one easily installed, space-saving construction.

THE MOTOR:

- 220/440 volts, 60 cps, 3 phase.

THE INDUCTOR-ALTERNATOR:

- *Wide choice of outputs.* Power range: Made in 1.5, 3, 5, 7.5 and 10 kw ratings at .8 power factor and with voltages of 120/208, 3 phase; 220/440 volt, 3 phase; 115/230 volt, single phase. Standard frequency 400 cps; other frequencies can be supplied.
- *Close voltage regulation.* Plus or minus 2%. (Plus or minus ½% can be furnished with special magnetic amplifier control).
- *Low maintenance.* No commutators, slip rings or rotor windings.
- *Low radio noise and harmonic content.*

THE CONTROLS:

- *Voltage regulator*—fast-acting automatic. Provision is made for adjusting voltage above and below normal values.

TYPICAL APPLICATIONS:

- Flight Simulators.
- Computers
- Aircraft Ground Support Equipment
- High-Frequency Machine Tools

The machine illustrated above is a 3 kw unit with many special design features not normally needed but indicative of variations available in this series of machines.

Write for complete information on standard designs—or outline your specific requirements for prompt attention by our Engineering Department.

ELECTRICAL DIVISION

including the STAR-KIMBLE product line

SAFETY INDUSTRIES, INC.

P. O. BOX 904 • TEL. UNiversity 5-3171 • NEW HAVEN 4, CONN.

ENTOLETER DIVISION
ELECTRICAL DIVISION

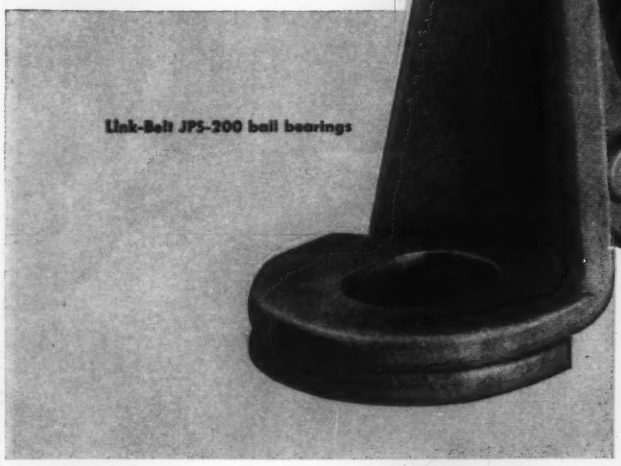
AUTOMATIC TIMING & CONTROLS, INC.
SAFETY RAILWAY SERVICE CORPORATION
INTERPROVINCIAL SAFETY INDUSTRIES LTD.

LIGHTING DIVISION
THE HOWE SCALE COMPANY

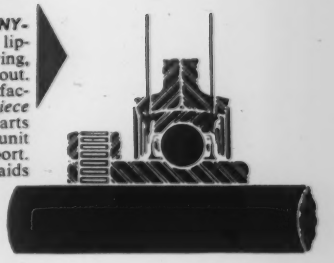
Motors • Generators • Disk Brakes • Special Motor-Generator Sets and Control Packages

Precision ... self-alignment

EVEN IN THIS LOW-COST BEARING



BEST SEAL AVAILABLE ANYWHERE! Synthetic rubber lip-type seal, integral with bearing, keeps lubricant in, dirt out. Bearing is greased at the factory and shipped in *one piece* . . . no juggling of sundry parts in assembly—simply slip unit on shaft and bolt to support. Its compactness further aids design flexibility.

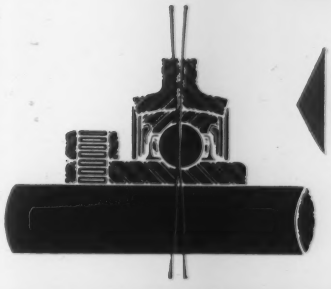


LINK-BELT JPS-200 ball bearings maintain capacity despite shaft and support deflection

In rugged field service, supporting structures on farm machinery and similar equipment undergo inevitable weaving. Shafts, too, are subject to dynamic deflections. Answer: *self-alignment* — the ability of Link-Belt bearings to adjust under these conditions. And it's yours *at low cost* in this precision Link-Belt ball bearing.

Equally important, Series JPS-200 bearings achieve their economy with *no loss of efficiency*. They combine sturdy pressed-steel housings with standard, full-capacity Link-Belt ball bearings.

Folder 2517 has complete data on the Link-Belt JPS bearing series, and Book 2550 covers the entire Link-Belt bearing line. Get both from any of 40 Link-Belt offices.

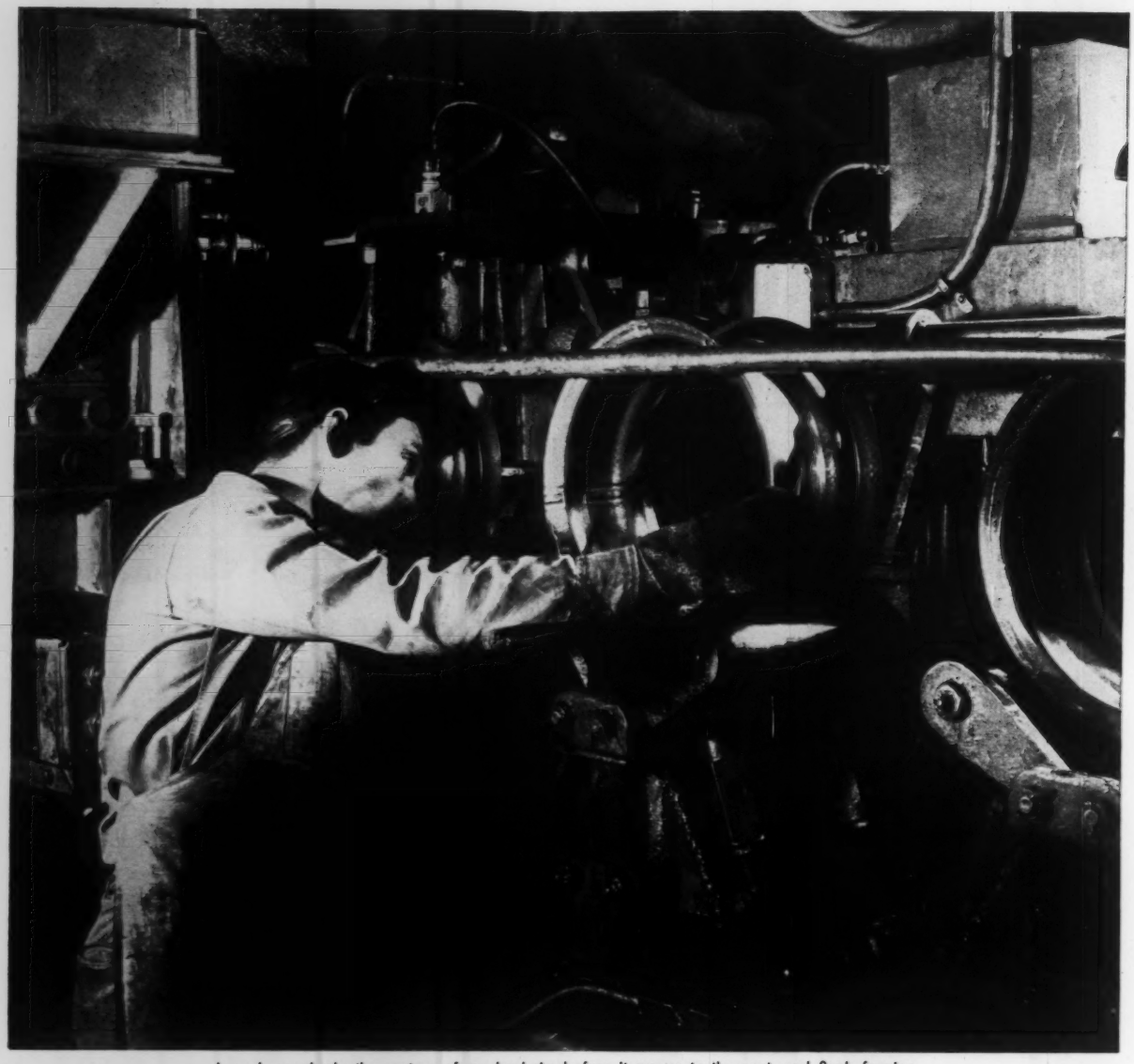


FREE ROLLING AND FULL LOAD CAPACITY are maintained even under shaft or support misalignment with Link-Belt self-aligning feature. Extra-long inner ring of bearing assures proper load distribution. Heavy spring-locking collar firmly secures bearing on shaft.

LINK-BELT

self-aligning ball and roller bearings

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World. 14,339-A



A workman checks the contour of a wheel rim before it passes to the next, and final, forming operation. Later, the rims will be welded to the hub and drum assembly to make the complete wheel.

Automobile wheels - a torture test for sheet steel

What a beating the wheels on your automobile must take! And how doggedly they stand up under their gruelling ordeal! Surely this is dramatic proof of the invincibility of strong sheet steel.

But the true torture test of steel sheets takes place in the actual making of the wheels themselves. Take rims for example. Here, the tough, strong sheet must be ductile enough to be spun to the complex contour required. It's no doubt one of the toughest tests imposed on steel sheets anywhere. Only top-quality sheets—like Bethlehem's—will take such severe punishment with uniform success.

Bethlehem sheets have been formed into hundreds of thousands of wheels for leading makes of automobiles. We'll gladly discuss your sheet steel needs, whenever it suits you. Just call our nearest office.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

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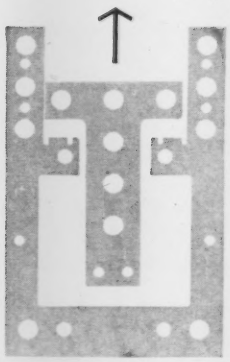
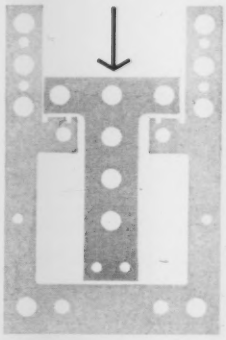
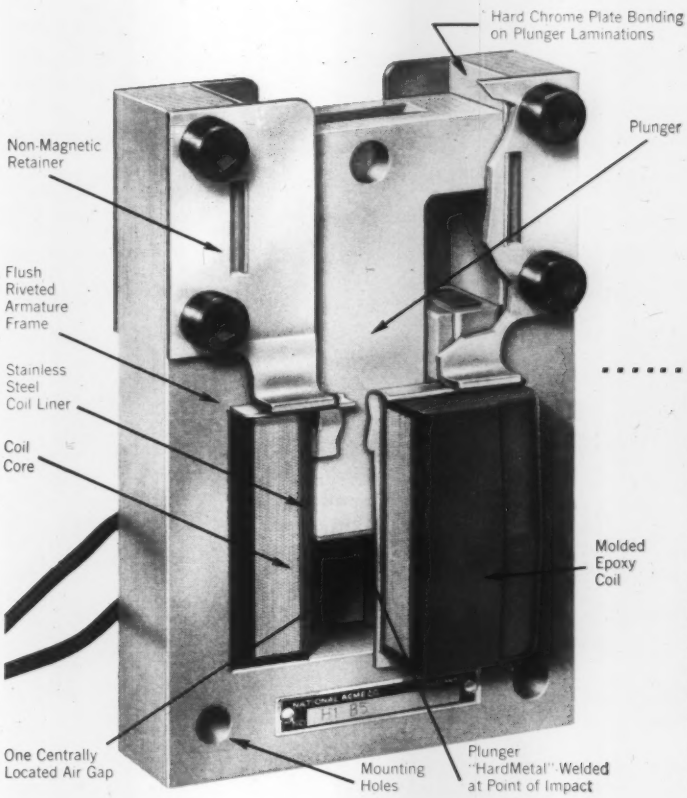
SOLENOID CHATTER ELIMINATED.....



.....

with the NEW NAMCO "Hard Metal"-Welded Solenoid





.....so quiet in its closed position, so rugged, so adaptable to any design problem, your application headaches are reduced to mere details!

Its noiseless operation permits solenoid applications never before considered practical. The usual chatter and clatter in the closed position is eliminated by a unique design that provides a positive three-point contact in the "holding position." Add to this Namco's exclusive "hard metal"-welded plunger bonding that prevents mushrooming at the vital point of contact; hard chrome-plated upper guide edges of plunger laminations that reduce friction and wear; superior electromagnetic qualities, and the result is a *silent performer* you can't afford to overlook.

Namco standard solenoids are available in a wide range of pull and push types with capacities up to 25 lbs.; custom-engineered solenoids in every size capacity and type can be made to meet your specifications. Write us about *your* application problems stating specific requirements.

National Acme

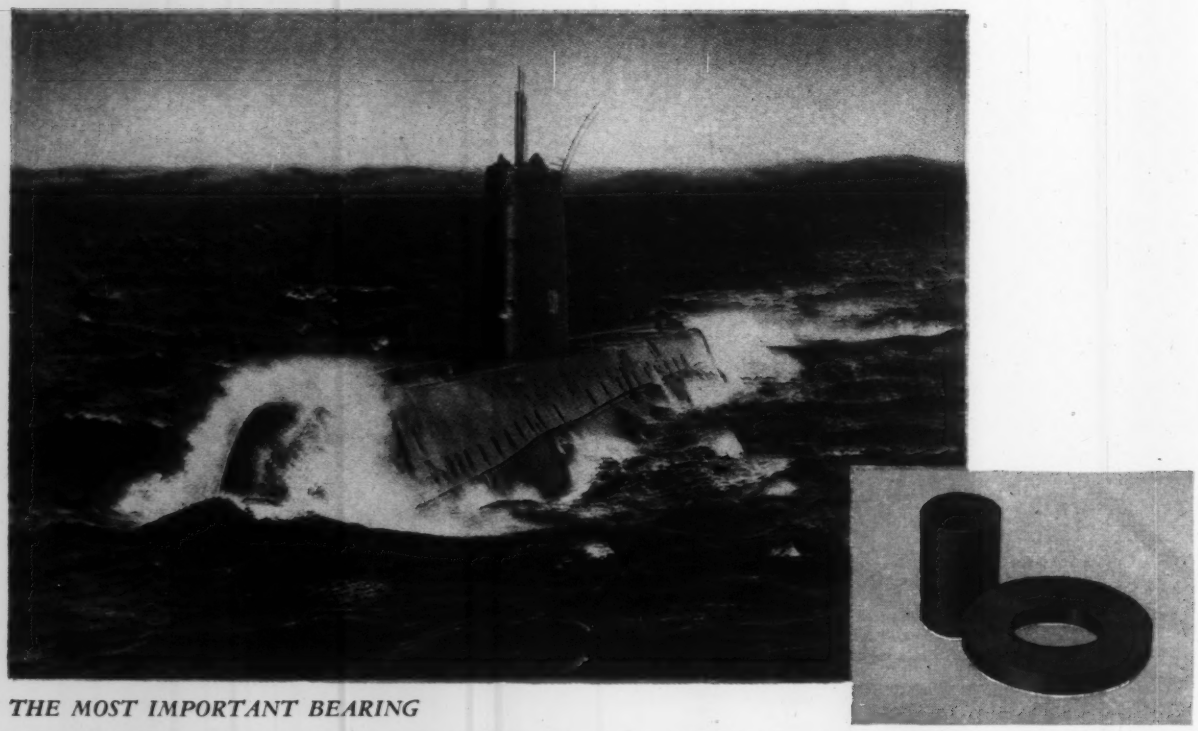
THE NATIONAL ACME COMPANY
188 East 131st Street
Cleveland 8, Ohio

Sales Offices: Newark 2, N. J., Chicago 6, Ill., Detroit 27, Mich.

Circle 445 on Page 19

Are your seals or bearings subject to difficult operating conditions?

GRAPHITAR® (Carbon Graphite) *has the specific properties needed in difficult applications like these . . .*

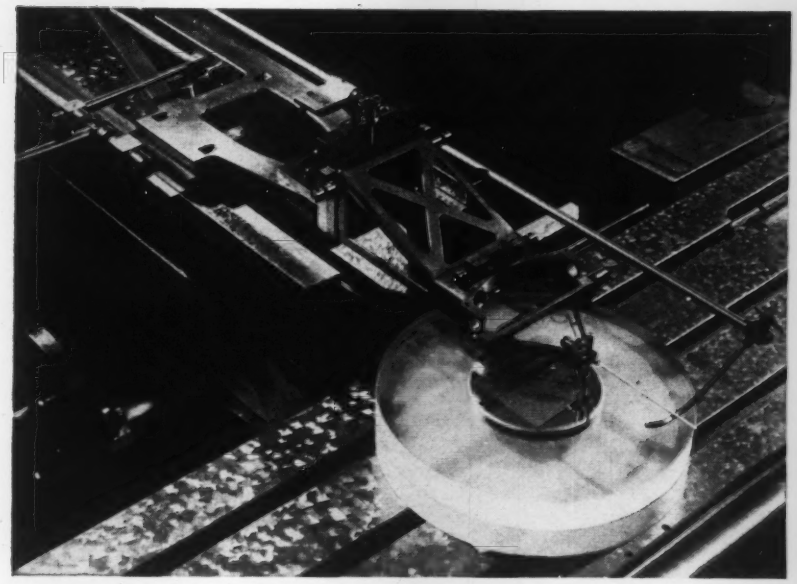


THE MOST IMPORTANT BEARING

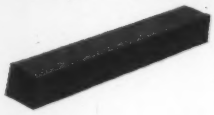
Dependability is vital in the power plant of the Navy's atomic submarine U.S.S. Nautilus which has steamed a total of about 50,000 miles of which approximately half has been submerged. In the reactor cooling system of the submarine, special "canned" motor pumps with integrated pump and drive motor were developed by Westinghouse. The bearings in these pumps, which are made of GRAPHITAR, must withstand high speeds, high temperatures, high pressures and must operate for indefinite periods of time without maintenance and with radioactive water as the only lubricant. Westinghouse Electric Corporation engineers—the builders of the Nautilus' atomic power-plant—find that GRAPHITAR is excellent for this difficult bearing application, because of its strength, durability, self-lubricating properties, and chemical inertness. If your design calls for superior bearings, consider the material that worked on such a demanding job.

THE UNITED STATES

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDERED METAL PARTS • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

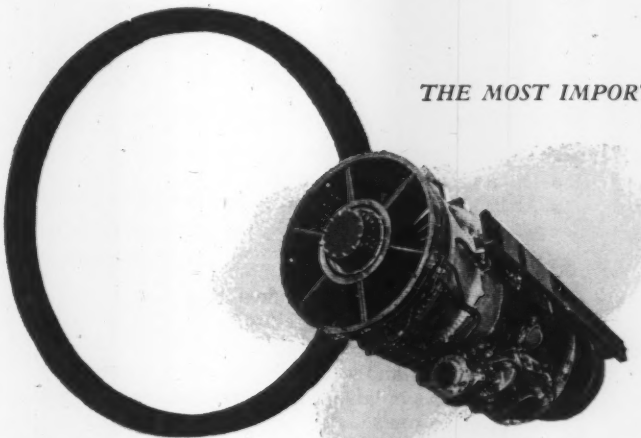


THE MOST EXACTING BEARING



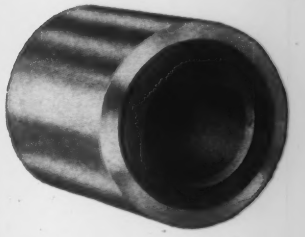
The Bausch & Lomb Optical Co. of Rochester, N.Y., world renowned manufacturer of precision, scientific optical instruments, employs 10 GRAPHITAR bearings in its unique and highly specialized "ruling engine." The GRAPHITAR bearings provide dimensional stability within one-millionth of an inch for micro-inch accuracy in cutting 15,000-30,000 equidistant lines to the inch on 7" aluminized glass blanks to make diffraction gratings used by science and industry for spectroscopic analysis. Bausch & Lomb engineers have found that GRAPHITAR is unsurpassed as a bearing material where very close tolerances must be maintained and where frequent starting and stopping under heavy loads is a problem. These bearings have contributed greatly to the achievement of extreme accuracy in this application. If you require precision performance as was the case with a "ruling engine" why not use GRAPHITAR?

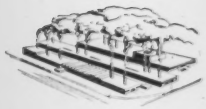
THE MOST IMPORTANT SEAL



GRAPHITAR is the main shaft seal in the Pratt & Whitney J57 turbojet engine which powers many of our new aircraft, including the huge Boeing B-52 Intercontinental Bomber, which has eight of these turbojets. Naturally, the J57 must perform with utter dependability. One of the components of the J57 is the air/oil seal of GRAPHITAR on the turbine main shaft, and this seal is subjected to tremendous shaft speeds, as well as other taxing physical conditions. GRAPHITAR parts can stand severe operation because they are strong and are virtually unaffected by extremes of speed, pressure, and temperature. If your product develops high speeds or other difficult physical stresses on its parts, perhaps GRAPHITAR components could give it more dependable operation.

THE TOUGHEST APPLICATION





Steel mills are famous for the rough, tough, heavy-duty jobs that they perform. In such difficult steel mill applications as bearings for shear and cut-off tables or coil and slab conveyors, metal-backed GRAPHITAR parts provide exceptional strength and durability. GRAPHITAR alone is a very strong bearing material, and when backed with metal has added resistance to shock. Because of its very low coefficient of friction, GRAPHITAR can operate under heavy loads at high speeds with no lubrication. Can the strength and superb bearing qualities of GRAPHITAR simplify your product design?

Get your copy of Engineering Bulletin No. 20.

GRAPHITAR is compacted from carbon-graphite powders under great pressures, then furnaced at heats near 4500°F. It can be formed in relatively complex shapes and ground to tolerances as close as .0005". For more information on this strong, light, self-lubricating engineering material, write for our Engineering Bulletin No. 20.

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GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 7, MICHIGAN

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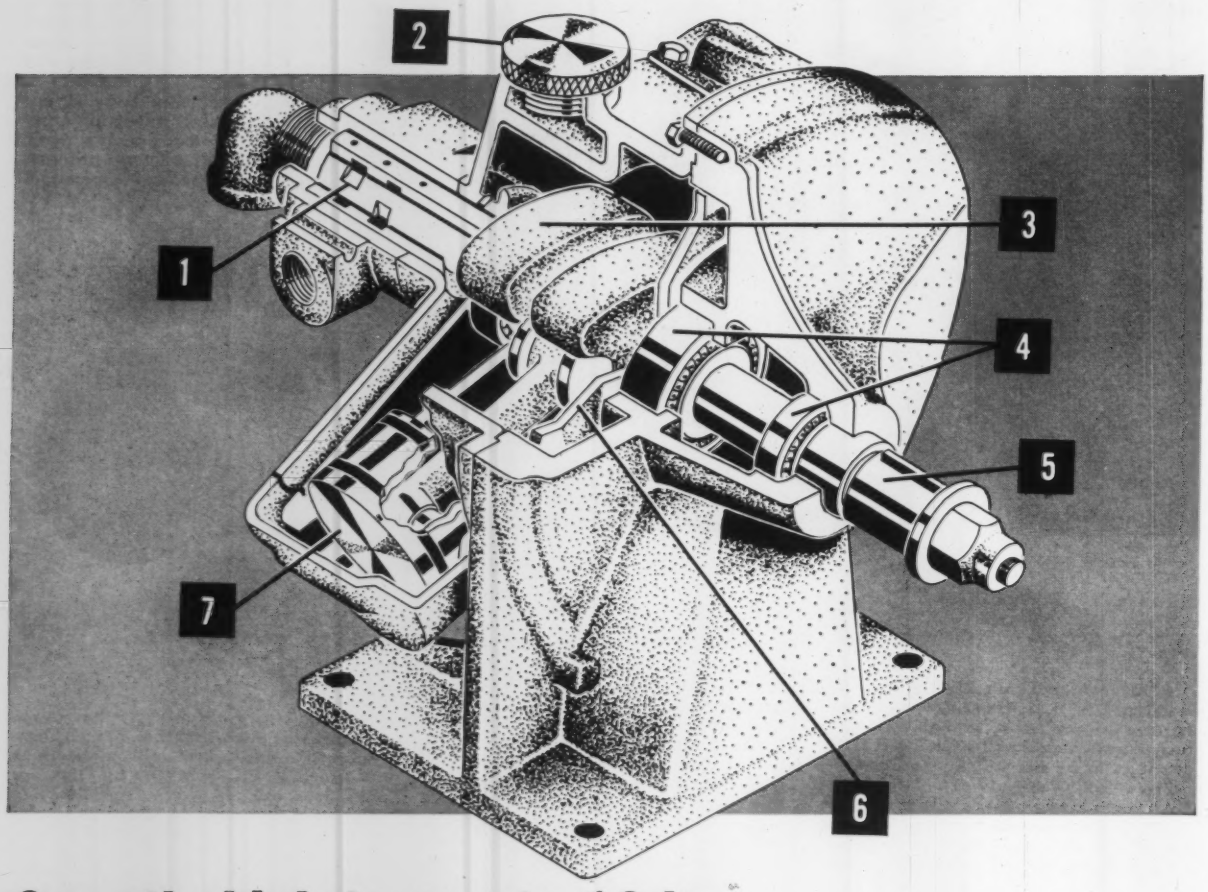


Smooth, high torque to 16 hp. ... Gardner-Denver 5-cylinder radial air motor

Check construction

1 Distributor valve for efficient compressed-air use.
2 Simple lubrication. Filler plug for crankcase oil—oils motor and bearings.
3 Counterbalanced crankshaft.
4 Heavy-duty, oil-lubricated roller bearings.
5 Rigid shaft supports overhung loads.
6 Oil slinger ring.
7 Automotive-type pistons and rings seal in power . . . save oil.

Check operation

- Smooth, even torque at all speeds . . . vibrationless operation.
- Accurate counterbalancing and overlapping power impulses.
- Extremely high hp in relation to air consumption.
- Not dependent on high rpm for power.
- Operates and consumes air only when working.
- At least two cylinders always on power stroke—three during part of cycle.

Check features

- High torque and control flexibility.
- Freedom from overload damage.
- Can't spark . . . can't burn out.
- Quick starts and stops . . . continuous operation.
- Six models available, with power and speed for variety of applications.
- Sizes from 2 to 16 hp.
- Direct drive or built-in gear reduction, reversible and non-reversible models.

For complete information, request Bulletin AM-1.

GARDNER-DENVER Since 1859 K KELLER TOOLS

ENGINEERING FORESIGHT—PROVED ON THE JOB
IN GENERAL INDUSTRY, CONSTRUCTION, PETROLEUM AND MINING

GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois
In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Avenue, Toronto 16, Ontario

Circle 447 on Page 19

TEAL rocket designed by TEMCO AIRCRAFT CORP., Dallas

What's the coolest insulator for hot products?

FORMICA® laminated plastic . . . . withstands 2500° F for 8 minutes in the Navy's XKDT-1 rocket drone. A modified standard Formica grade successfully insulates the solid propellant engine case and blast tube against this inferno.

This is the heat insulator Formica research developed by combining great mechanical strength with high heat resistance. It has helped break the heat barrier in aviation, missile and space craft.

This type of heat insulator can be useful in your hot products, too. In fact, product designers are getting more "assists" from Formica laminated plastics than any other material. Standard grades available for immediate use in your projects . . . without extensive delays for research and development. Forty-eight hour Streamliner shipment of most grades. For further information, write for bulletins 829 and 856-A. Formica Corporation, subsidiary of American Cyanamid, 4514 Spring Grove Ave., Cincinnati 32, Ohio.

FORMICA®
Laminated Plastic

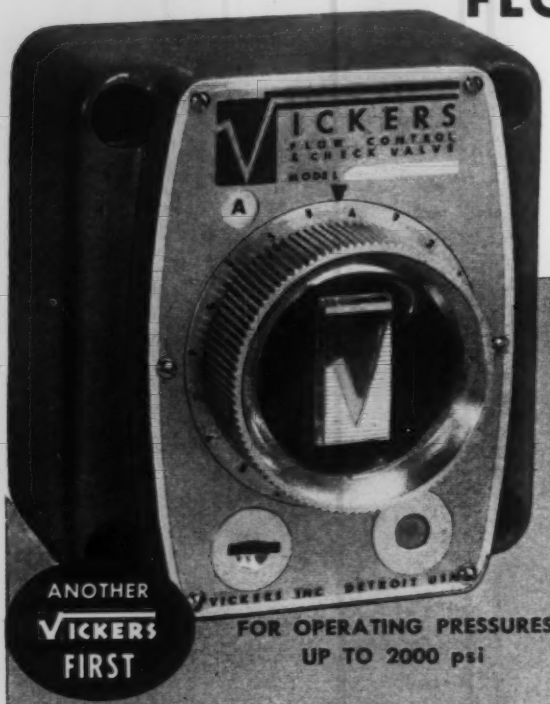
a product of CYANAMID

Circle 448 on Page 19

11-1965

RECEIVING ENTHUSIASTIC ACCEPTANCE

VICKERS® New ¼" Temperature and Pressure Compensated FLOW CONTROL VALVE



ANOTHER VICKERS FIRST

FOR OPERATING PRESSURES UP TO 2000 psi

For years the Machine Tool Industry has been asking for a combination Temperature and Pressure Compensated Flow Control Valve to minimize feed rate changes. Now for the first time it is available as a production unit at a reasonable price.

Check THESE EXCLUSIVE FEATURES that mean Optimum Tool Life and Better Work Finish:

- **TEMPERATURE COMPENSATED**
  Virtually constant feed rates all day long with same throttle setting because throttle automatically compensates for changes in oil temperature. The compensator mechanism is simple in design and durable.
- **PRESSURE COMPENSATED**
  Constant feed rate throughout entire cycle because built-in pressure hydrostat automatically compensates for load changes.
- **SINGLE THROTTLE COMPLETE RANGE ADJUSTMENT**
  Greater flexibility because valve is adjustable within entire flow range of 5 to 1000 cubic inches per minute.
- **REVERSE FREE FLOW AS STANDARD FEATURE**
  A standard feature which permits reverse free flow (up to 1400 cu. in. per min.) from outlet to inlet port by-passing control elements.
- **TAMPER-PROOF ADJUSTMENT**
  Retention of original feed rate is assured because a set screw prevents inadvertent throttle movement and a cover over the set screw can be locked in place.
- **INTERCHANGEABLE**
  This new valve replaces 12 previous models and it is interchangeable with all of them, also the drain connection is eliminated on the new valve to simplify piping.
- **GREATER ECONOMY**
  No need to stock several valves for wide range of flow rates. Drain connection is eliminated, piping costs are reduced.
- **MAXIMUM RELIABILITY AND ACCURACY**
  Design of temperature and pressure control components assures maximum circuit reliability and extreme accuracy of feed through a range of 5 to 1000 cubic inches per minute.

FOR ADDITIONAL INFORMATION SEND FOR I-195040 8143

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
Machinery Hydraulics Division
ADMINISTRATIVE and ENGINEERING CENTER
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Application Engineering Offices: ATLANTA • CHICAGO • CINCINNATI CLEVELAND • DETROIT • GRAND RAPIDS • HOUSTON • LOS ANGELES AREA (El Segundo) • MINNEAPOLIS • NEW YORK AREA (Springfield, N.J.) PHILADELPHIA AREA (Media) • PITTSBURGH AREA (Mt. Lebanon) PORTLAND, ORE. • ROCHESTER • ROCKFORD • SAN FRANCISCO AREA (Berkeley) • SEATTLE • ST. LOUIS • TULSA • WORCESTER

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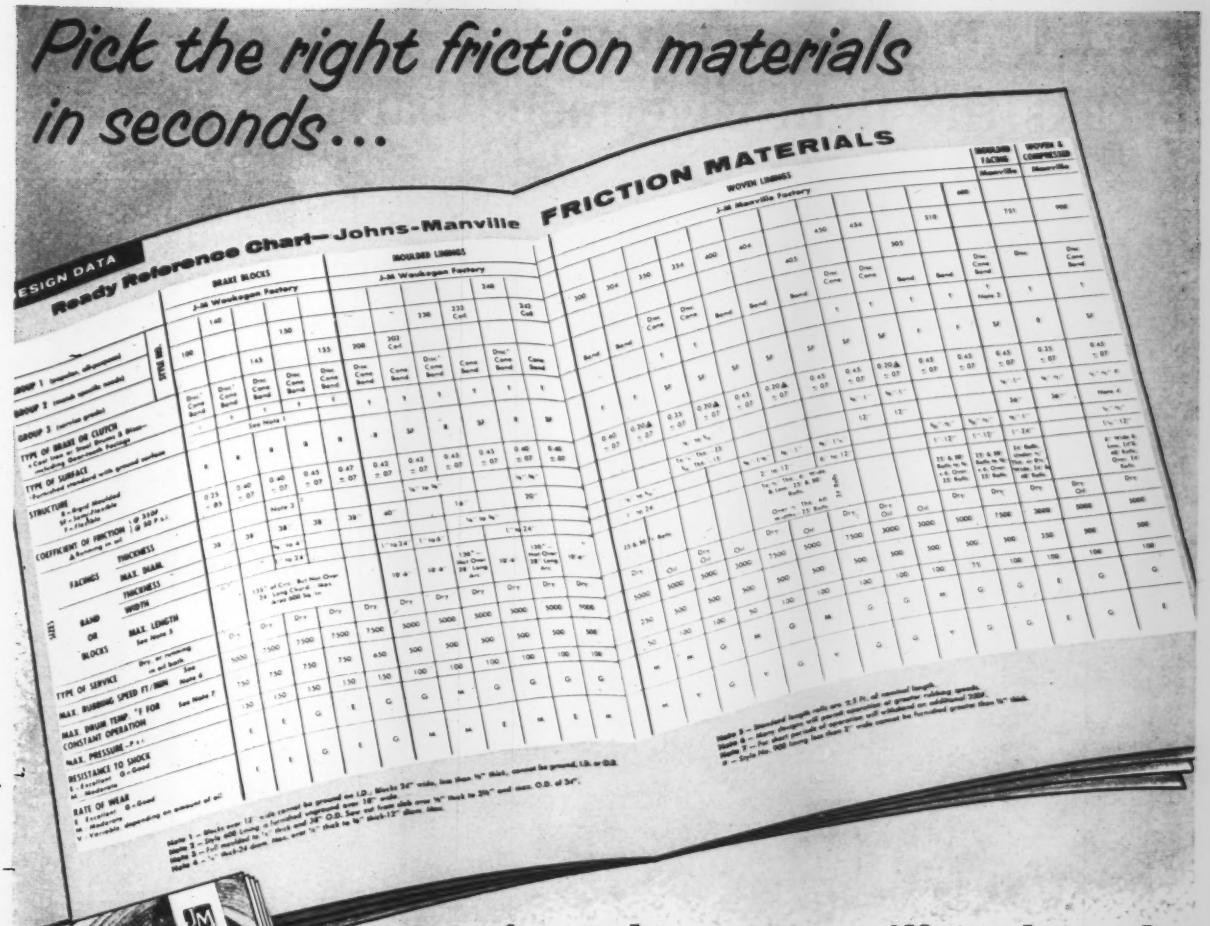
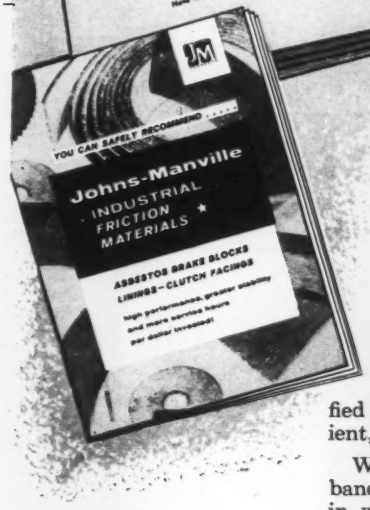
ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

Pick the right friction materials in seconds...





It's in Johns-Manville's handy new Friction Materials Selector

WHEN YOU ENCOUNTER a design problem that involves the control of motion, you'll find this new, ready-reference book about Johns-Manville Friction Materials a big help. Its sixteen pages are loaded with specific design data, presented in simplified table form, that you'll find convenient, accurate and easy to use.

Whether you require a disc, cone, band, block or lining—for application in wet or dry service, heavy or light duty, slow or high speed operation, light or heavy pressure—this book will give you performance characteristics, available sizes and shapes, dimension data and tolerances.

Whatever your problem dealing with the control of motion the J-M Friction Material specialist . . . backed by unmatched J-M Research facilities . . . is at your service. Write Johns-Manville, Box 14, New York 16, N.Y., for your free copy of the Friction Materials Guide—FM35A. *In Canada, Port Credit, Ont.*

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville *Industrial* FRICTION MATERIALS

Circle 450 on Page 19

HELIARC Welding
breaks the light-gage metal barrier

Welding stainless steel sheet into a smooth, streamlined shape for jet plane fuel tanks is a production job for HELIARC Welding. This method, utilizing a tungsten electrode shielded by LINDE Argon, was developed by LINDE especially for use on hard-to-weld commercial metals.

HELIARC Welding can be used either automatically or manually, in all manual welding positions. LINDE Argon in bulk or in cylinders—99.995% pure—protects the weld. Since no flux is required, joints are clean and smooth, without spatter, saving you time and money.

Get more information about HELIARC Welding. For a free copy of the booklet, "Modern Methods of Joining Metals," write Box Q103. LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. Offices in other principal cities. *In Canada*: Linde Company, Division of Union Carbide Canada Limited.

Fuel tanks for jet planes, made of thin stainless steel, are quickly assembled with smooth, clean and sound seams by HELIARC Welding, a LINDE development.

FOR THE BEST IN ELECTRIC WELDING—LOOK TO LINDE!

Linde TRADE-MARK
UNION CARBIDE

The terms "Linde," "Heliarc," and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

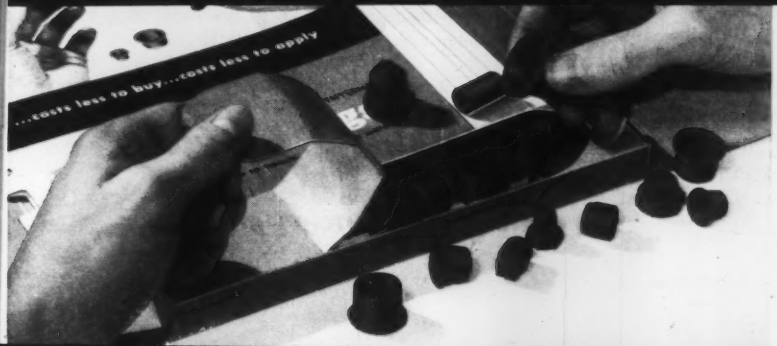
chances are you'll find Caplugs ideal for your closure needs, too . . . they're made of tough, flexible Polyethylene . . . easy to apply and a cinch to remove . . . won't chip, break, shred or collapse . . . over 500 sizes in a dozen different styles now on the shelf.

Caplugs

QUICK, SLICK PROTECTION FOR PRODUCTS IN PROCESS, STORAGE AND TRANSIT

Circle 452 on Page 19

GET THIS KIT FULL OF SAMPLES IN EXCHANGE FOR THE COUPON ATTACHED



CAPLUGS DIVISION, PROTECTIVE CLOSURES CO., INC
2201 Elmwood Ave., Buffalo 23, N.Y.

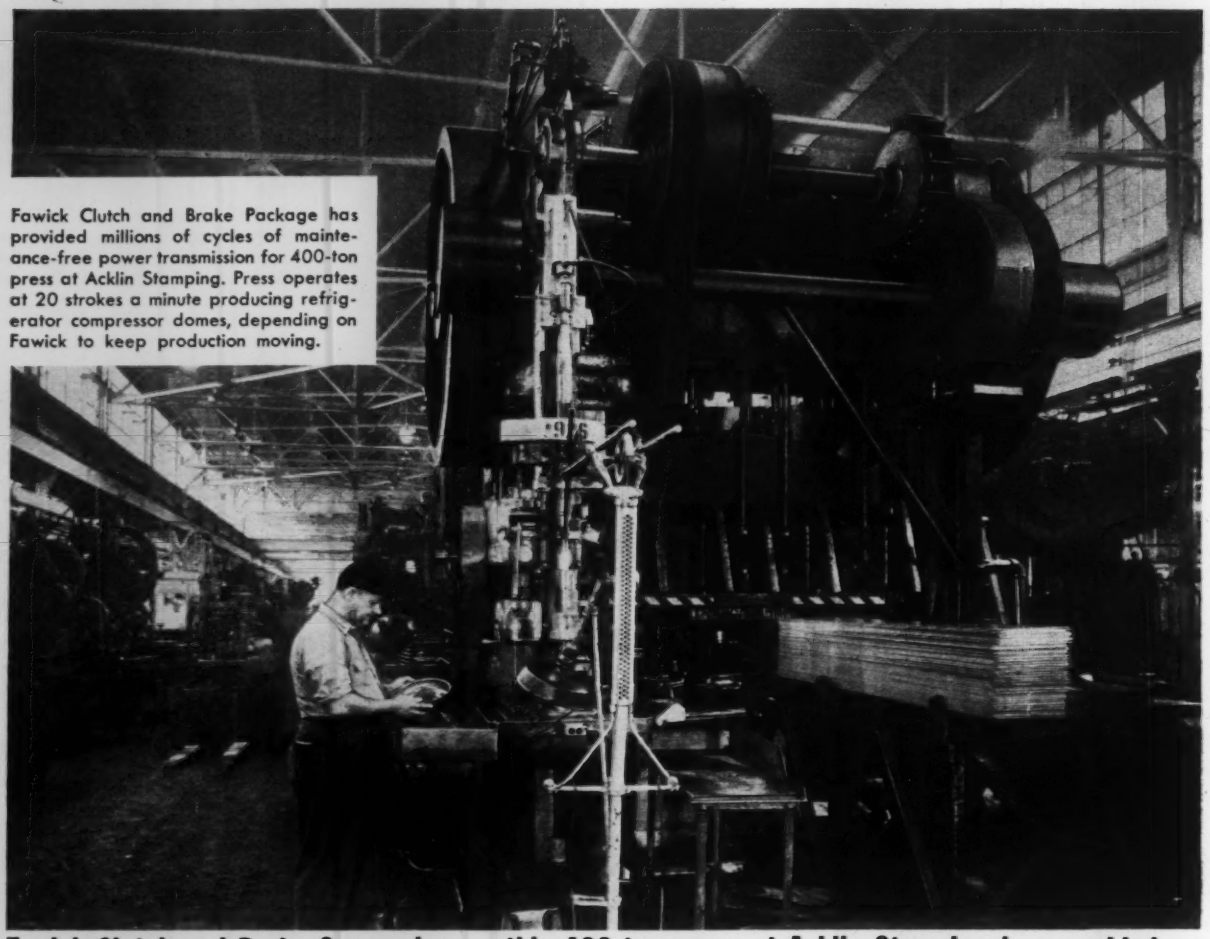
Mail a free assortment of Caplugs, literature an prices to us, without obligation.

NAME _____ TITLE _____

FIRM _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____



Fawick Clutch and Brake Package has provided millions of cycles of maintenance-free power transmission for 400-ton press at Acklin Stamping. Press operates at 20 strokes a minute producing refrigerator compressor domes, depending on Fawick to keep production moving.

Fawick Clutch and Brake Conversion on this 400-ton press at Acklin Stamping has provided

"new machine" performance for millions of cycles . . . *and still going strong!*

Dependable power transmission is the heart of today's high-speed, heavy-duty production machinery. It is vital in helping every plant manager achieve his goal—uninterrupted production.

Millions of cycles ago, Acklin Stamping Division of Tecumseh Products Company (Toledo, Ohio) installed a FAWICK Clutch and Brake Package on a 400-ton press. Since then, according to Philip C. Wood, Works Manager, ". . . the press has operated with virtually no lost time or maintenance cost due to clutch or brake."

The press is equipped with a heavy-duty FAWICK VC Ventorque Clutch and Type "E" Air-Ring Brake, designed and built for the most severe applications. Ventilated construction prevents heat build-up and permits cooler, longer-lasting operation. This reduces wear and lengthens shoe life. Maintenance is restricted to routine inspection, keeping non-productive time and costs at a minimum.

For more information on how you can reduce non-productive time through dependable power transmission, contact your nearest FAWICK representative or the Home Office today.

FAWICK AIRFLEX DIVISION
FAWICK CORPORATION
9919 CLINTON RD. • CLEVELAND 11, O.
In Canada, Fawick Canada, LTD., Toronto

FAWICK Airflex
INDUSTRIAL CLUTCHES AND BRAKES

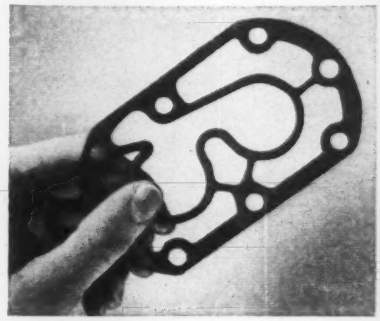
Circle 453 on Page 19

Technical data for gasket design and selection

NUMBER FIVE

Choosing a gasket for compressors

In selecting a gasket material for a compressor head, the first consideration is the gasket's ability to withstand the usual ambient temperature of about 300° F.



At such elevated temperatures, and with internal pressures ranging well over 100 psi, torque retention becomes another critical factor.

In the case of refrigerator compressors, the choice of a gasket is further limited by the presence of refrigerant gases which attack many gasket materials.

A material that meets these requirements is Accopac AN-890, a new beater-saturated gasket material pioneered by Armstrong. Accopac AN-890 is a blend of refined asbestos fibers with a nitrile-type rubber binder.

AN-890 withstands temperatures up to 800° F. Its nitrile-type rubber binder swells slightly in the presence of refrigerant gases. Since these gases do not deteriorate AN-890, the swelling acts to maintain a tight seal.

Bolt torque retention of Accopac AN-890 has been proved by comparing a flange containing refrigerant gas at 350° F. and 150 psi, and a control flange at room temperature and no gas. Accopac maintained bolt torque equally well in both flanges.

Because of the thorough refining of the asbestos fibers, AN-890 die-cuts cleanly. It also costs less than conventional asbestos materials.

For more information, write for a copy of our new folder, IND-915.

How heat affects the selection of resilient gasket materials

In selecting a resilient gasket material for use where the temperature at the gasket line will be substantially higher than room temperature, the various effects of heat must be considered.

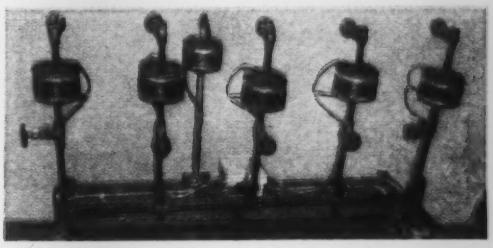
In many cases, heat is less of a limiting factor than is commonly supposed. If a designer knows the range of temperature limits of the various classes of resilient gasket materials (see table), he may find that a resilient material offers service equal to a more expensive gasket.

A more subtle effect of heat—and one more difficult to detect—is the softening it tends to produce in almost any non-metallic gasket.

Generally, this is manifested by things variously known as torque loss, stress relaxation, and creep. Because of plastic flow or some form of fatigue, high temperatures tend to reduce the ability of a resilient gasket to maintain flange pressures over relatively long periods.

Loss of bolt torque induced by heat can be minimized by selecting a gasket material with good torque retention properties. The Armstrong Accopac line includes several such materials. Generally, the denser the gasket the better its torque-retention properties, (see table). In addition, where heat is involved, it is all the more important that initial bolt loads be adequate.

A more complete discussion of the effects of heat on resilient materials is contained in the new Armstrong Gasket Design Manual. Write for your copy today.



This apparatus—called the "hot spider"—permits simultaneous testing of gasket materials at temperatures up to 750° F. and internal pressures up to 500 psi under varying conditions of flange loading.

Class of material	Maximum sustained temperature at gasket line*	Rank in order of torque retention
Asbestos	750° F.	1
Cellulose	300° F.	2
Cork-and-rubber	250° F.	3
Straight rubber	250° F.	4
Cork composition	250° F.	5

*These are recommended design limits. Obviously, in many applications temporary exposure to higher temperatures can be tolerated. Consideration should also be given to nature of contained fluids, since some fluids which are inert at room temperature become more active as temperatures increase.

Resilient gaskets usually are organic, and exposure to high temperatures can cause physical damage such as charring. If charring does occur, the damage will, of course, be obvious and leaks will result. This can generally be avoided by staying within recommended limits of the material or by using an inorganic gasket such as Armstrong asbestos Accopac.

Send for a copy of the new Gasket Design Manual, IND-763, containing 34 pages of valuable information for engineers. Armstrong Cork Co., 7010 Dean Street, Lancaster, Penna.

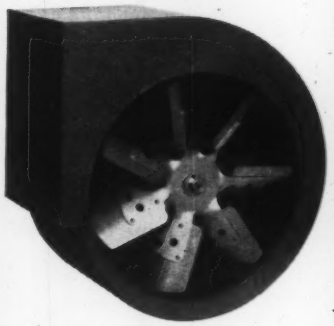
Armstrong GASKET MATERIALS

. . . used wherever performance counts

Circle 454 on Page 19

TRY THIS FOR SIZE

IT'S THE GREAT NEW TORRINGTON MIXED-FLOW RADIAX ▮ 6 SIZES FROM 300 TO 3000 CFM ▮ SAVINGS UP TO $10 PER UNIT ▮ SIZE, WEIGHT AND MOTOR ECONOMY ▮ PLUS TORRINGTON REPUTATION ▮ FULL DETAILS AND ENGINEERING SERVICE ON REQUEST



IN YOUR '59 DESIGNS

THE TORRINGTON MANUFACTURING COMPANY

TORRINGTON, CONNECTICUT • VAN NUYS, CALIFORNIA • OAKVILLE, ONTARIO

Circle 455 on Page 19

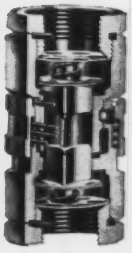
*Snap-Tite

QUICK-CONNECT
QUICK-DISCONNECT COUPLINGS

in larger sizes

immediate delivery
FROM FACTORY STOCKS

Snap-Tite's "H" Couplings are now factory-stocked for quick shipment to you, not only in the smaller sizes (below 1" ID) but in all sizes up to and including 3"—in steel, brass, aluminum, and 303 and 316 **Stainless Steel.** And "H" Couplings can be made to your order, up to 10" ID.



Available with valves to give two-way or one-way automatic line shut-off, or without valves for straight-thru flow, "H" Couplings are built to handle high pressures in hydraulic and air systems.

Recessed valve washers . . . fluted valve stems . . . valve stops with minimum flow restrictions . . . large inside diameter—allow maximum flow capacity with lowest pressure drop.

See the Snap-Tite representative in your city or write for Bulletin 240.

SNAP-TITE'S "H" COUPLING, SIZE FOR SIZE, IS THE SMALLEST COUPLING WITH HIGHEST STRENGTH AND HIGHER EFFICIENCY

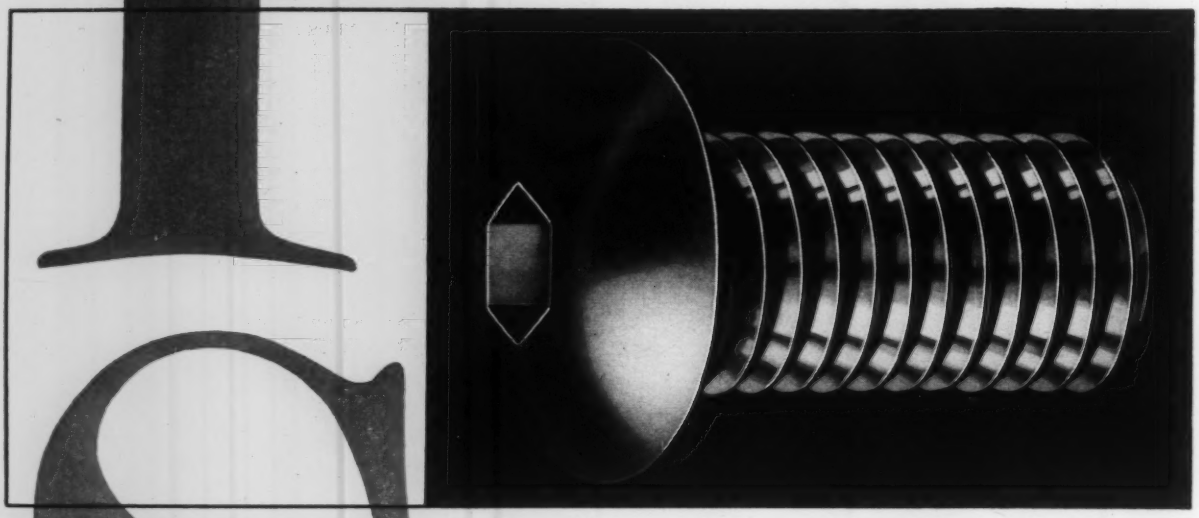
*Snap-Tite, INC.
UNION CITY 11, PENNSYLVANIA

SNAP-TITE COUPLINGS CAN HANDLE ALMOST ANYTHING THAT FLOWS

Circle 456 on Page 19

Problem:

"Fasten thin metal parts where countersinking is impractical. Product is to have smooth, streamlined surface, so fastener head must be low and rounded. Fasteners must be removable . . . must stand up under repeated removal and re-tightening . . ."



Solution:

HOLO-KROME BUTTON HEAD CAP SCREWS. Made of special analysis alloy steel heat-treated to 38-42 Rockwell "C" hardness. Sockets are scientifically proportioned for highest strength . . . especially important in shallow button head sockets. Internal Hex socket drive assures a smooth, unmarred head. New forging method results in improved fiber flow, tougher screws. Threads are Unified Class 3A fit.

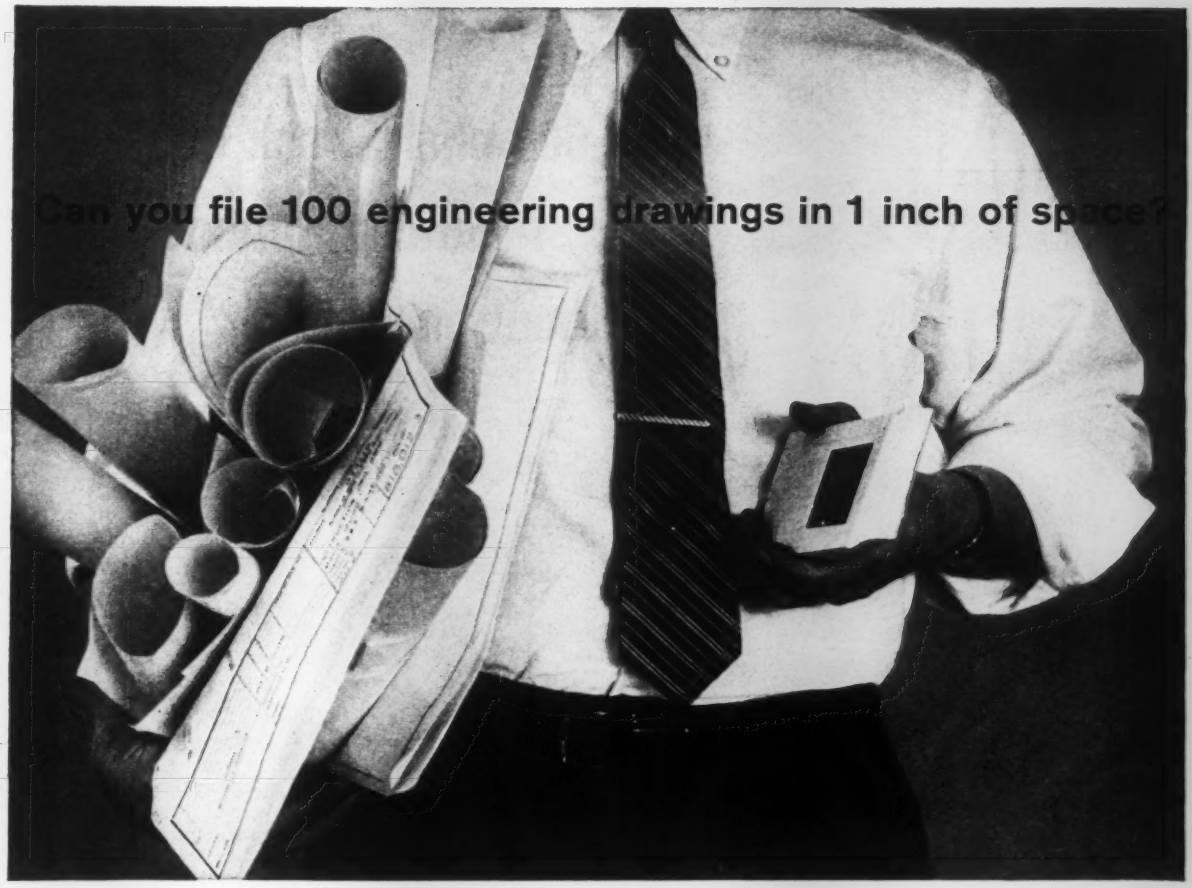
For the finest in Hex Socket Screws . . . for unmatched Same-Day Service, the name to remember is Holo-Krome.

HOLO-KROME SOCKET SCREWS

THE HOLO-KROME SCREW CORPORATION • HARTFORD 10, CONN.

SOLD ONLY THROUGH AUTHORIZED HOLO-KROME DISTRIBUTORS

Circle 457 on Page 19



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Simply mail the coupon below for the name and location of your local Service Center. You will also receive, without obligation, the Microline booklet giving you the complete story, and containing a special free offer which will dramatically demonstrate what this advanced new system can do for you.

microline

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Please send me the name and location of my local Microline Service Center. Also, the booklet giving the complete Microline story and containing a free demonstration offer.

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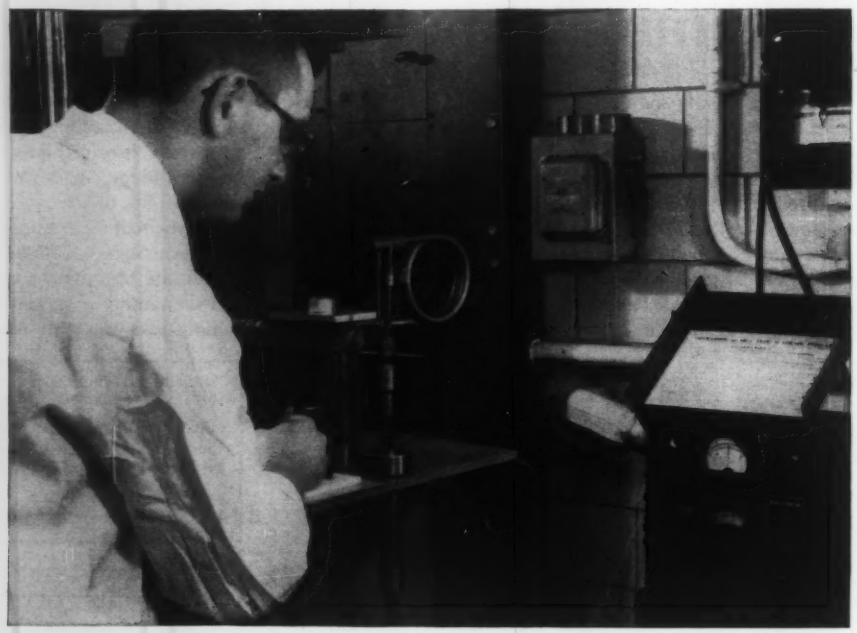
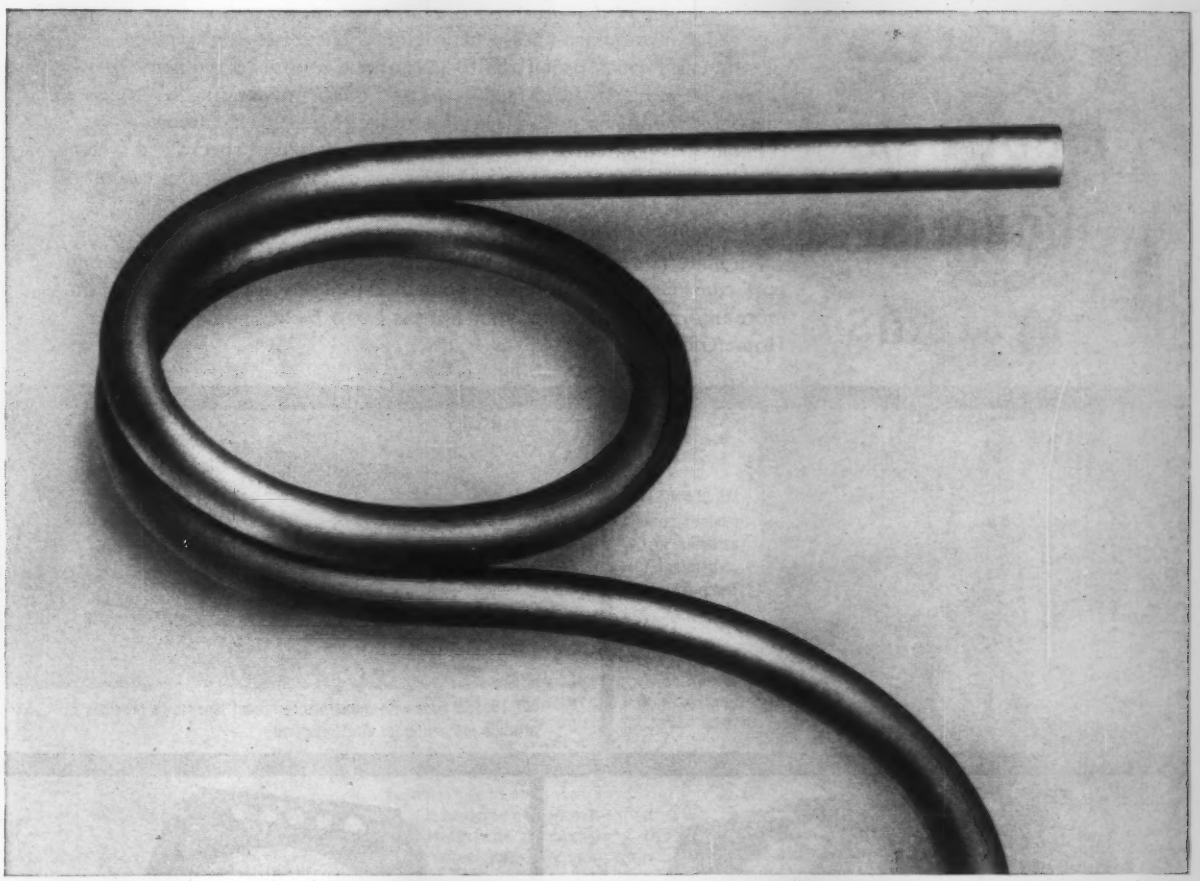
Circle 458 on Page 19

20,000 chairs rock on USS American Springs without one failure

...thanks to AS&W

In the American Steel & Wire Spring Testing Laboratory, the springs recommended for the Homecrest Chair go through extensive tests. This Fatigue machine, by means of strain-gauge verification, simulates years of use in a relatively short testing time.





Here is the spring recommended by American Steel & Wire for use in this chair. To supplement the AS&W tests, the Homecrest Company subjected these springs to a simulated rocking test. Under a weight of 250 pounds, these springs were rocked 750,000 times, without failure.

Spring Engineering Research Service

The Homecrest Company, Wadena, Minnesota, wanted to add a swivel rocking chair to their line of modern, functional home furniture. However, they would produce this chair only if it could be a quality item that would give good, dependable service. While designing the chair, they checked with the American Steel & Wire Spring Engineering Consulting Service. The engineers studied the problem, ran extensive tests and finally recommended a pair of round wire helical single coil torsion springs. Using these springs, Homecrest designed, fabricated and marketed the chair. Today 20,000 of these chairs have been sold and not one failure of an AS&W Spring has been reported.

Mr. A. L. Englemann, a partner of Homecrest Company, says, "We have purchased from American Steel & Wire over 45,000 springs, and not one has been reported a failure. We couldn't be happier with American Steel & Wire as a supply source for our springs."

If you have a spring problem, or would like advice on the use of springs in your product, get in touch with any American Steel & Wire Sales Office. You can benefit from the knowledge of AS&W's Spring Engineering Research Service. The Service has been engaged in laboratory experiments of static and dynamic testing for 20 years and has accumulated invaluable data on stress and fatigue life of steel springs, while endeavoring to improve efficiency in the use of steels, from steel chemistry through product application, to more economically cope with today's rigorous demands. This accumulated knowledge of the AS&W Spring Engineering Research Service is at your disposal.

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American Steel & Wire
Division of USS **United States Steel**

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors • Tennessee Coal & Iron Division, Fairfield, Ala., Southern Distributors • United States Steel Export Company, Distributors Abroad

Circle 459 on Page 19

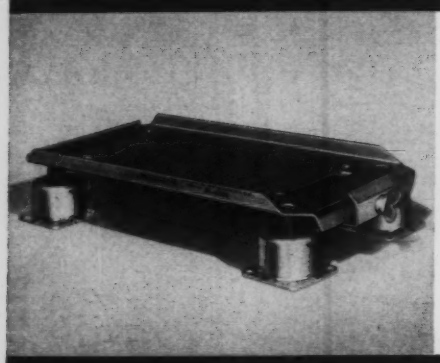
LORD electronic mounting systems

LORD designs and manufactures *complete*, assembled mounting systems in a wide range of standard and special designs. These provide excellent vibration and shock protection for airborne electronic equipment.

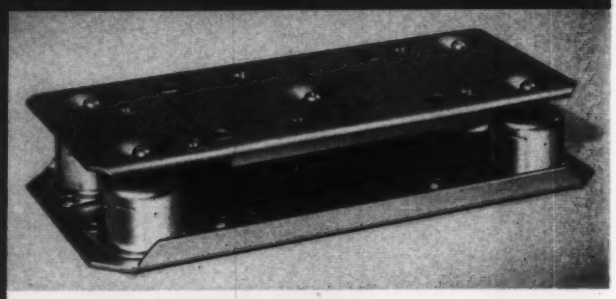
With recently expanded facilities, LORD offers outstanding service on all types of standard bases to meet all pertinent MIL specifications.

Extensive experience can be applied to the design of specialized systems to meet high-performance requirements or to withstand environmental extremes such as high temperatures, high frequencies, steady-state accelerations and transient shock conditions.

All materials and designs are selected to satisfy both performance and cost considerations. To initiate your mounting system project or obtain more information, contact your nearest LORD Field Engineer or the Home Office, Erie, Pa.

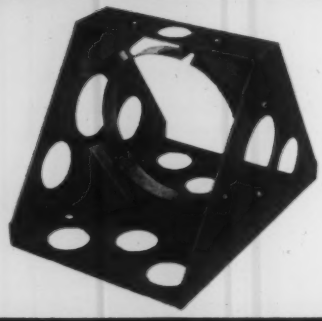


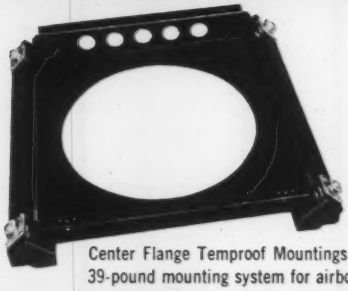
MS-91404-S1 mounting base assembly incorporates Temproof Mountings.



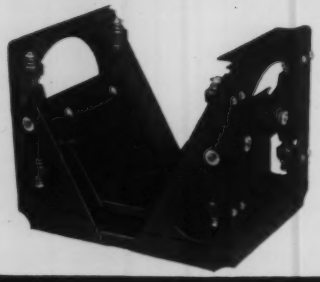
MT-1555/U base with miniature Temproof Mountings provides all-attitude protection for electronic unit.

Special all-attitude base with BTR (Broad Temperature Range) Mountings for gyro in jet-powered aircraft.



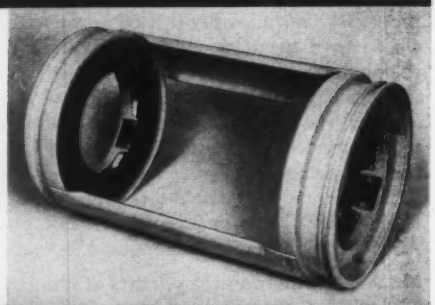


Center Flange Temproof Mountings are used in 39-pound mounting system for airborne antenna harmonizer.



Custom-designed rectilinear mounting system protects missile gyro against rotation from translational inputs.

High-performance mounting system for missile protects canister-type electronic units of modular design.



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LORD MANUFACTURING COMPANY · ERIE, PA.

LORD

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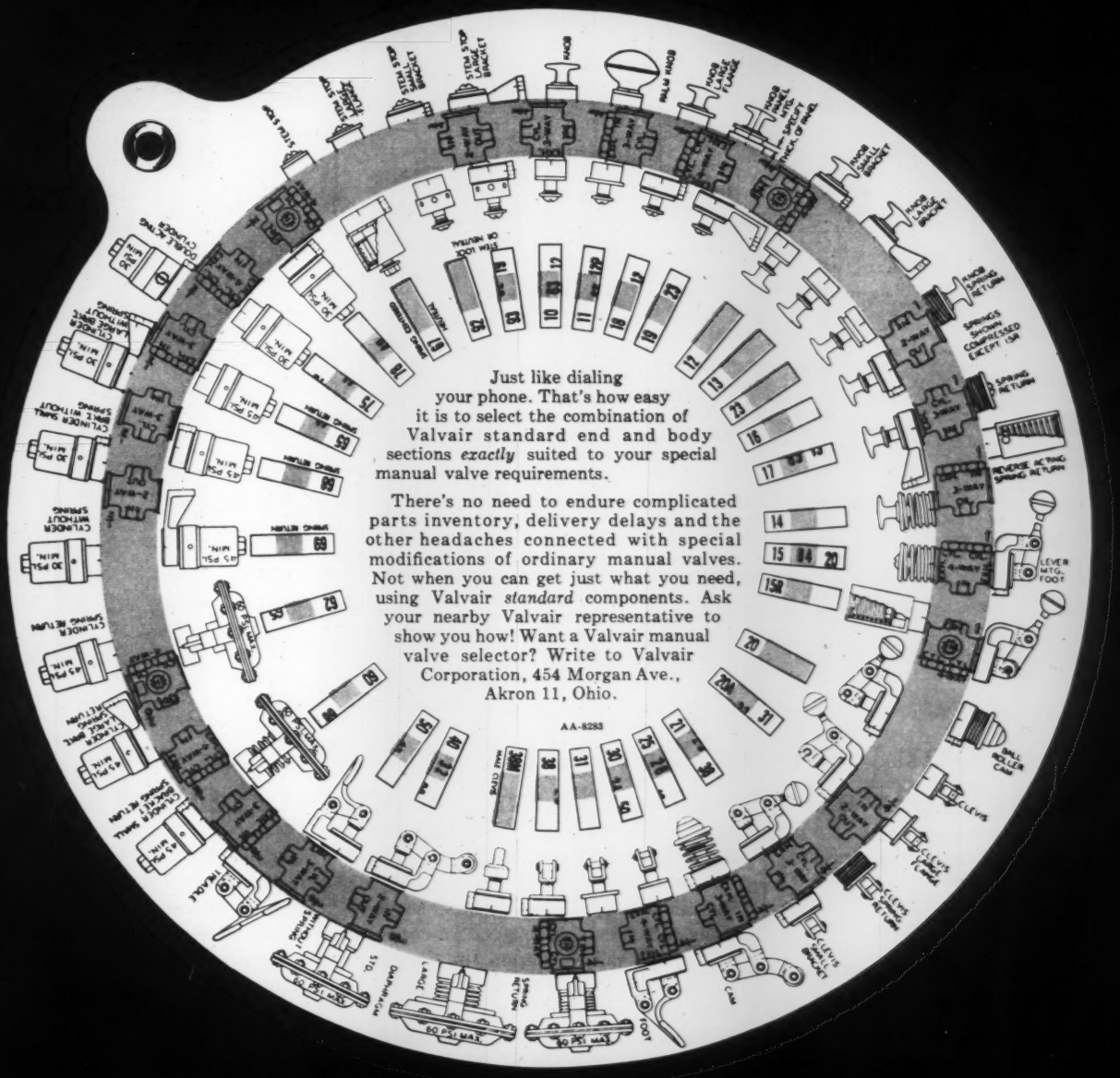
Circle 461 on Page 19→

Valvair manual valves

. . . unlimited combinations using standard components!


Just like dialing your phone. That's how easy it is to select the combination of Valvair standard end and body sections *exactly* suited to your special manual valve requirements.
There's no need to endure complicated parts inventory, delivery delays and the other headaches connected with special modifications of ordinary manual valves. Not when you can get just what you need, using Valvair *standard* components. Ask your nearby Valvair representative to show you how! Want a Valvair manual valve selector? Write to Valvair Corporation, 454 Morgan Ave., Akron 11, Ohio.
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Compare and you'll buy

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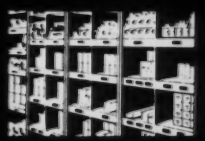
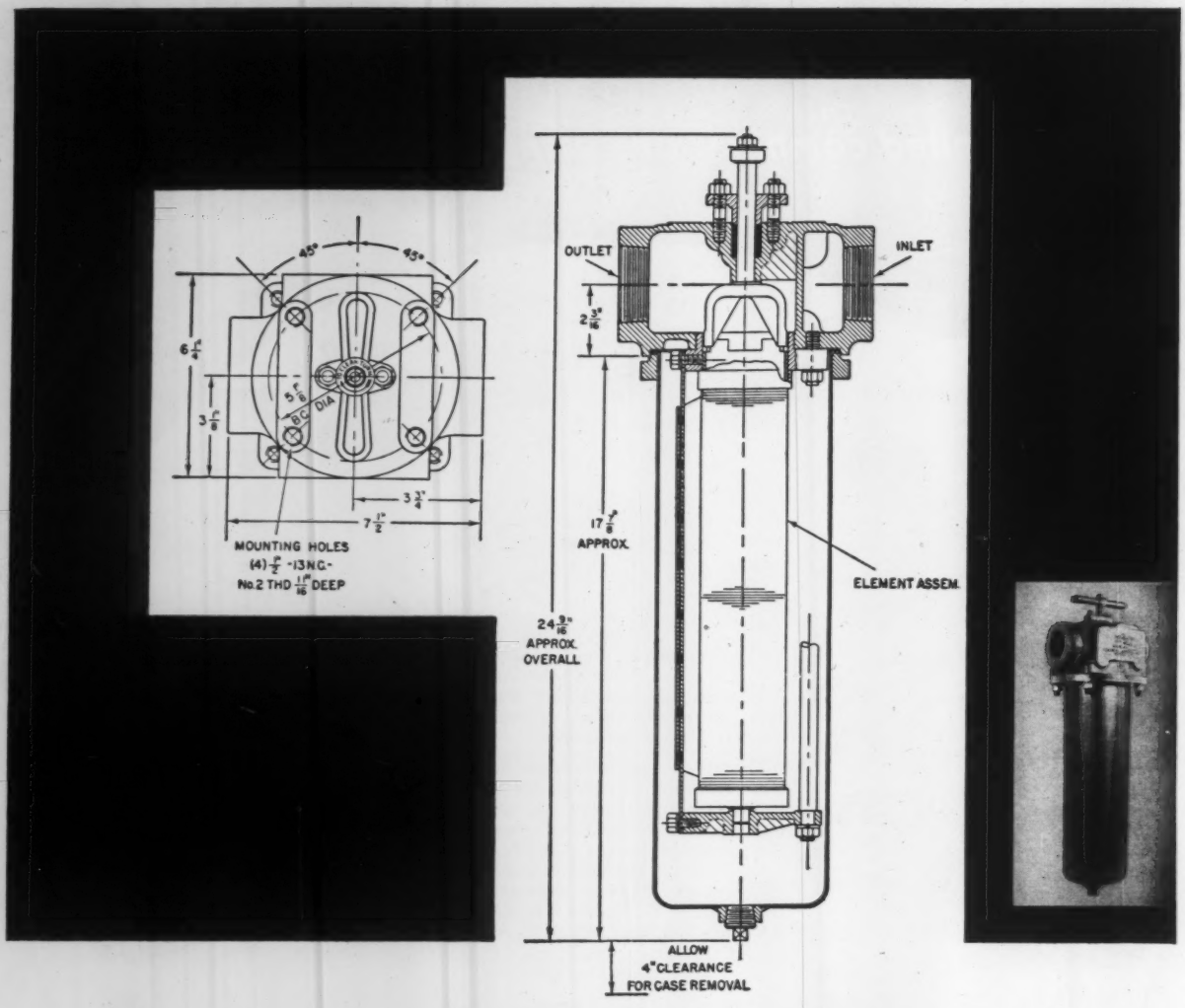


Immediate delivery from local stock

Representatives in principal cities



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FOR EXAMPLE... This one standard Purolator filter is exactly right for all these "special" filtration problems:

inks, paints,
varnishes, machine tool coolants,
greases, vitamin solutions,
as well as fuel and lube oils.

This filter's specifications may recommend it for a problem of yours. If not, you're almost certain to find a standard Purolator filter that does meet your needs—exactly.

SPECIFICATIONS... This is Purolator filter model G-141J with simplex full flow metal element oil strainers. It is designed for primary or first stage filtration and can be installed on pressure or suction side of pump. Recommended for maximum capacities of 40 to 80 GPM, dependent on spacing which varies from .003 to .010. Relief valves set from 10-12 to 50 PSI are incorporated in several models. Motor driven knife blade to clean element can be furnished whenever conditions make manual rotation impractical. Head is made of high tensile cast iron, body of drawn steel. Inlet and outlet connections are 2", drain plugs are provided. Maximum pressure: 125 PSI; weight: 37 lbs.

Remember, if these specifications don't match your needs, there's probably a filter that does at Purolator. Find out. Send in your problem.

Filtration For Every Known Fluid

PUROLATOR

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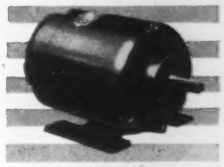
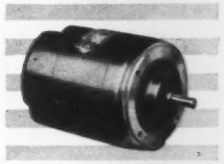
Circle 462 on Page 19

DESIGN FLEXIBILITY
plus PROVEN PERFORMANCE....

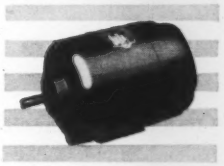
R&M UNIVERSAL MOTORS



foot mounting



end mounting



pad mounting

When you build-in R&M Motors... you build in customer satisfaction

R&M Universal Motors have proven to be dependable performers in hundreds of OEM products used by millions of satisfied customers. You can be sure your product will give more years of reliable, trouble-free operation if it's powered by R&M.

Design engineers prefer R&M Universal Motors for their broad design flexibility. Consider these variables on standard models: AC or DC operation . . . 1/50 to 1/2 hp . . . pad, foot or end mounted . . . rotation in either direction . . . open or totally enclosed. Custom designs with special ratings are also available.

Build customer satisfaction into your next product! Write today for R&M Bulletin 444-MD!

ROBBINS & MYERS, INC.

SPRINGFIELD, OHIO / BRANTFORD, ONTARIO

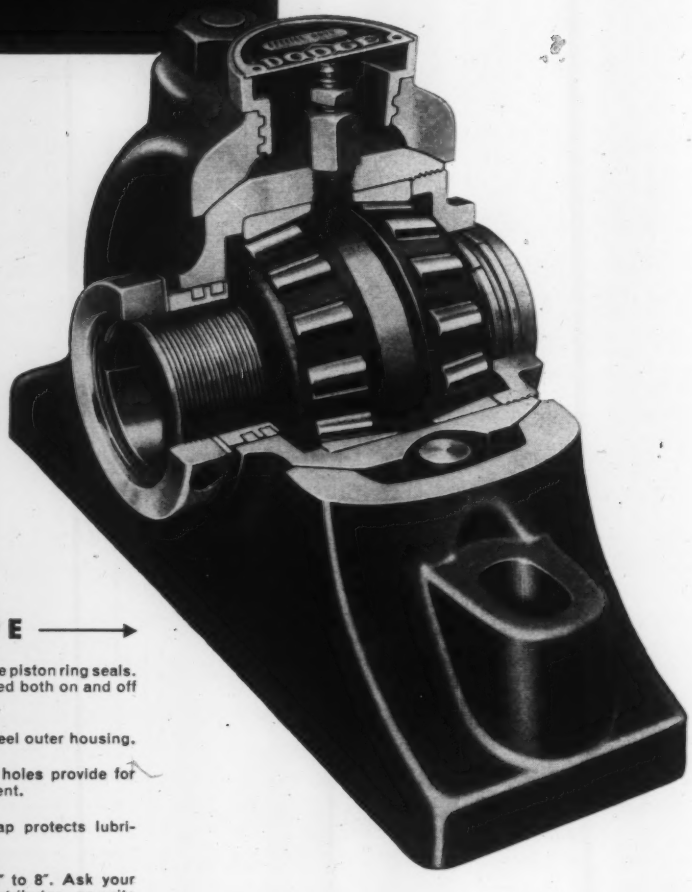
Robbins & Myers build motors from 1/200 to 200 horsepower

Circle 463 on Page 19

DODGE PILLOW BLOCKS

Timken Bearing Equipped

America's super-quality line—with a 34-year record of keeping performance *up* and costs *down!* Five types—to fit practically any service condition. All assembled, adjusted, lubricated and *sealed* at the factory for precision performance—long life—dependability.



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- Designed for extreme precision and high load capacities.
- Fully self-aligning.
- Special Duplex Timken Roller Bearing with tapered bore.
- Split tapered sleeve with straight cylindrical bore extends through entire length of housing.
- Easy to mount or demount. Adapter nut (or collar) clamps adapter sleeve to shaft with extreme firmness.
- Automotive type piston ring seals. Bearing is sealed both on and off the shaft.
- Rugged semisteel outer housing.
- Elongated bolt holes provide for lateral adjustment.
- Special dust cap protects lubrication fitting.
- Shaft sizes 1¾" to 8". Ask your local Dodge Distributor—or write us for Bulletin A670 giving complete technical data on America's most complete line of mounted bearings.

DODGE MANUFACTURING CORPORATION, 3300 Union St., Mishawaka, Ind.

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look in the *white* pages of your telephone directory for "Dodge Transmissioneer."

DODGE
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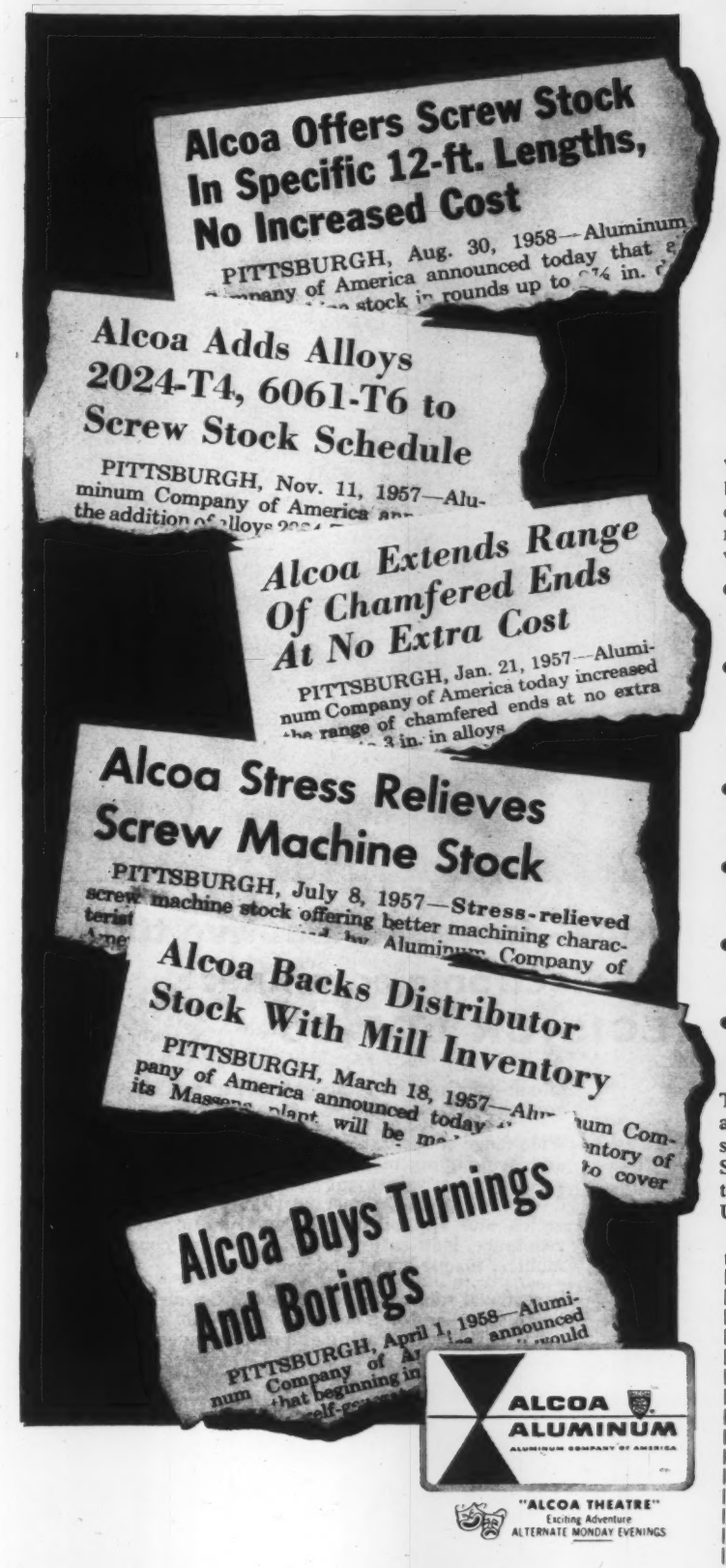
Circle 464 on Page 19

DESIGN FREEDOM STARTS WITH ALCOA ALUMINUM


Alcoa Offers Screw Stock In Specific 12-ft. Lengths, No Increased Cost
PITTSBURGH, Aug. 30, 1958—Aluminum
Alcoa Adds Alloys 2024-T4, 6061-T6 to Screw Stock Schedule
PITTSBURGH, Nov. 11, 1957—Aluminum Company of America
Alcoa Extends Range Of Chamfered Ends At No Extra Cost
PITTSBURGH, Jan. 21, 1957—Aluminum Company of America today increased
Alcoa Stress Relieves Screw Machine Stock
PITTSBURGH, July 8, 1957—Stress-relieved
Alcoa Backs Distributor Stock With Mill Inventory
PITTSBURGH, March 18, 1957—
Alcoa Buys Turnings And Borings
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THE BIG NEWS IN SCREW MACHINE STOCK COMES FROM ALCOA

We think there's more to service than making the best screw machine stock readily available in any quantity. ALCOA is consistently a step ahead with new economies, new design and production conveniences. Here are six ALCOA "firsts":

- Specific 12-ft lengths at no extra cost—all screw stock in rounds to 2⅞ in. dia. and hexagons to 2 in. across flats.
- Alloys 2024-T4 and 6061-T6 added to Screw Stock schedule. This means important economies through the addition of sizes formerly nonstandard which are now standard and groupable for price advantage.
- Chamfered ends at no extra cost for all rounds and hexagons up to 3 in. in alloys 2011-T3, -T8, 2017-T4, 2024-T4, 6061-T6.
- Full screw stock size range of alloys 2017-T4, 2024-T4, 6061-T6 stress relieved for improved machining characteristics.
- Mill inventory to supplement distributor stock and cover emergency requirements of mill customers.
- ALCOA agrees to purchase up to 60 per cent of customer's turnings and borings generated from alloys 2011-T3, 2017-T4, 2024-T4 and 6061-T6.

These and other reasons have prompted designers and production engineers of leading industries to switch to ALCOA® Aluminum Screw Machine Stock. The whole story, with direct quotes, is in three new ALCOA booklets—yours for the asking. Use the coupon.

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Please send your case-history booklets containing quotes from leaders in industry on why they buy from Alcoa.

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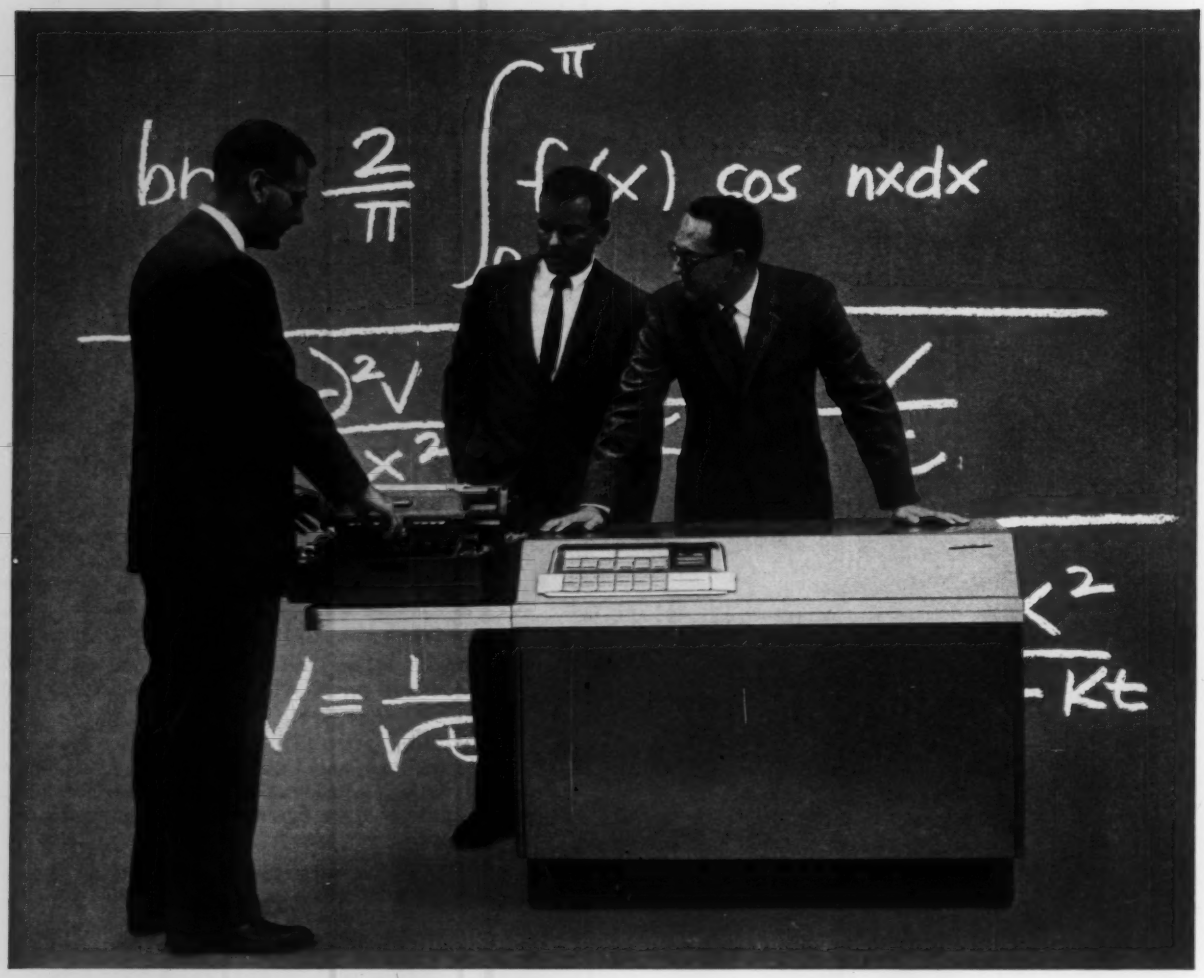
Circle 465 on Page 19



Speed routine calculations—increase creative time with this powerful electronic computer

ROYAL PRECISION LGP-30

Large capacity... easily programmed and operated... mobile... low in cost

Compact, simple to use, Royal Precision LGP-30 will today bring high-speed computation *right to your desk* ... thus relieve you of the tedium of standard hand calculations... increase available time for truly creative work... help you simulate optimum designs in a matter of minutes. And at the lowest cost ever for a complete computer system!

Unusual capacity. Operating from a standard wall outlet, performing an almost unlimited range of calculations, LGP-30 gives you the flexibility of stored-program operation combined with speed, memory (4096 words) and capacity equal to computers many times its size and cost. Completely mobile, LGP-30 is easily wheeled from room to room, building to building.

Simple to operate and program. LGP-30 controls have been so thoroughly simplified that it may be operated with only minimum computer experience. Direct print-out of answers – no deciphering required. Programming is easily learned—even by non-technical personnel. Library of sub-routines, plus programs for a wide variety of applications, is available.

Wide range of applications. In addition to general design and system optimization, LGP-30 is currently being used for the refinement of estimates; computation of design parameters; specification of new product properties and capabilities; calculation of such data as reactance, load saturation curves, time constants, harmonics, torque-speed and vee curves.

Exceptional value; complete service. Smallest initial investment ever for a complete computer system is combined with low operating and maintenance costs. Service facilities coast-to-coast.

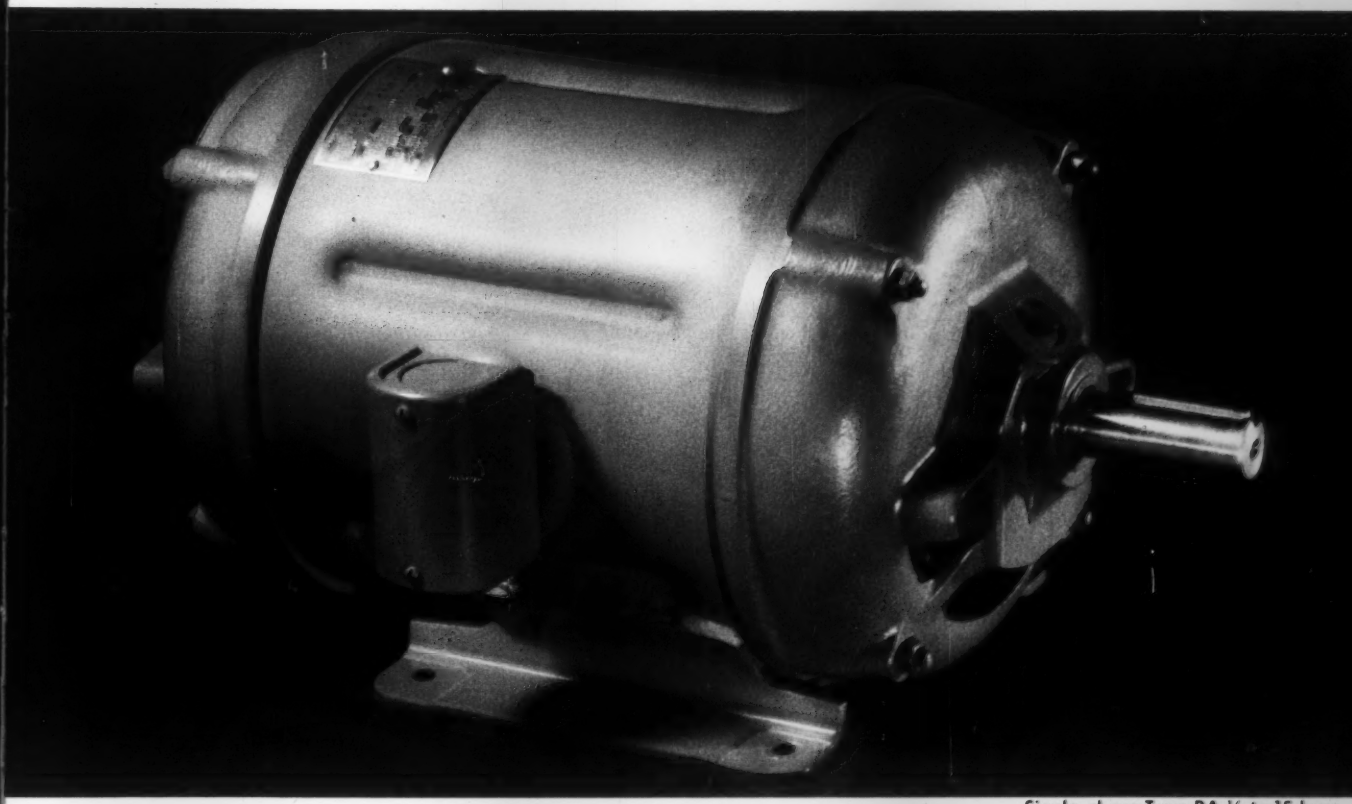
For further information and specifications, write Royal McBee Corporation, Data Processing Division, Port Chester, N. Y.

ROYAL McBEE
data processing division

Circle 466 on Page 19

Circle 467 on Page 19→

Got a Real Tough Starting Problem ?



Single-phase Type RA ½ to 15 hp.

Wagner Repulsion-Start Induction Motors start heavy loads with low current

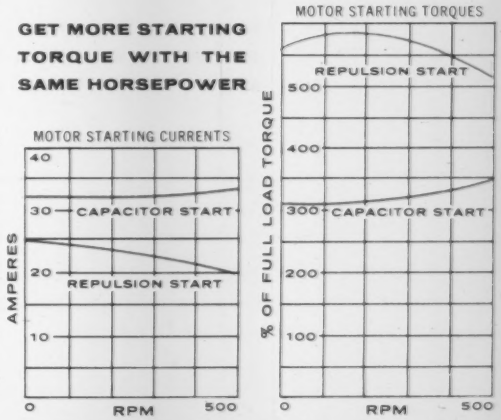
The Wagner Type RA is the work-horse of the single-phase motor field. It combines high starting torque for quick, easy starts with low starting current and minimum light flicker. It has a constant high operating speed, even under overload, and a flat efficiency curve over a wide operating range.

You practically eliminate service problems when you power tough single-phase applications with Wagner RA Motors. They have unmatched ability to start high inertia or heavy friction loads repeatedly and they give many years of unfailing service.

Let a Wagner Sales Engineer show you how these motors can be applied to your needs. Call the nearest branch office or write for Bulletin MU-220.

Wagner Electric Corporation
6400 Plymouth Ave., St. Louis 14, Mo.
BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

GET MORE STARTING TORQUE WITH THE SAME HORSEPOWER



ONE HP, 1750 RPM, 60 CYCLES, 230 VOLTS

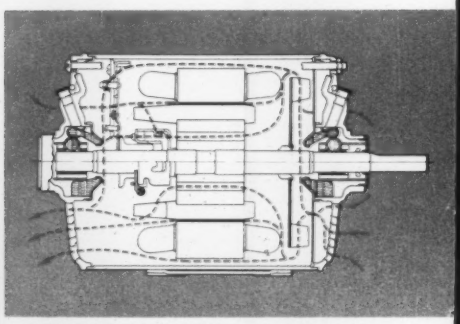
Integral Ratings, 1-5 hp are available in the latest NEMA Frame Sizes

H. P.	OLD FRAME SIZE	PRESENT FRAME SIZE
1	203	182
1½	204	184
2	224	213
3	225	215
5	254	254U

4 pole (1750 RPM, 60 cycle and 1450 RPM, 50 cycle) ratings are interchangeable in mounting dimensions with capacitor start motors of the same ratings.

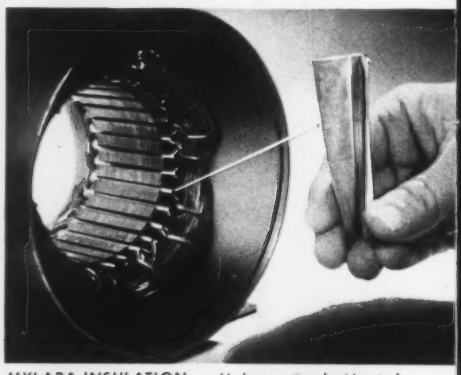
Got a Normal Starting Application?

Single-phase
Type RK
⅙ through 5 hp.



EFFICIENT COOLING SYSTEM—The improved ventilating system used in these motors directs a large volume of air through the motor to effectively reduce temperatures and add to motor life. Cross section above indicates direction of air flow.

QUICK BREAK SWITCH—The starting winding and capacitor are disconnected from the line by this Wagner Switch—test-proved to make more than a million makes and breaks . . . the equivalent of two starts per hour for 50 years.



MYLAR* INSULATION — Mylar-paper laminated slot insulation gives top protection against moisture, adds thermal stability, to give more application versatility and longer life when unexpected overloads occur.

*DuPont Trademark

WAGNER CAPACITOR-START MOTORS provide dependable starts... long troublefree life

Here's the single-phase general purpose motor that gives more horsepower with less bulk—is rugged enough to permit direct mounting, compact enough to fit in tight spots. Available with sleeve or ball bearings — with rigid bases or with resilient mountings for exceptionally quiet operation.

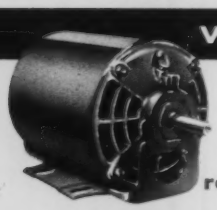
ALL-ANGLE OPERATION

The sleeve bearing design in fractional hp ratings, has a positive lubrication system that permits operation in any position. All angle mounting can mean important savings in initial costs to manufacturers—can help the design engineer in a tight spot.

You can get these motors from leading motor distributors in your community and from Wagner Sales Offices in 32 principal cities. Your Wagner Sales Engineer will be glad to help you select the right motor for your application. Wagner Bulletin MU-217 gives full details.

Wagner Electric Corporation
6400 Plymouth Ave., St. Louis 14, Mo.
BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

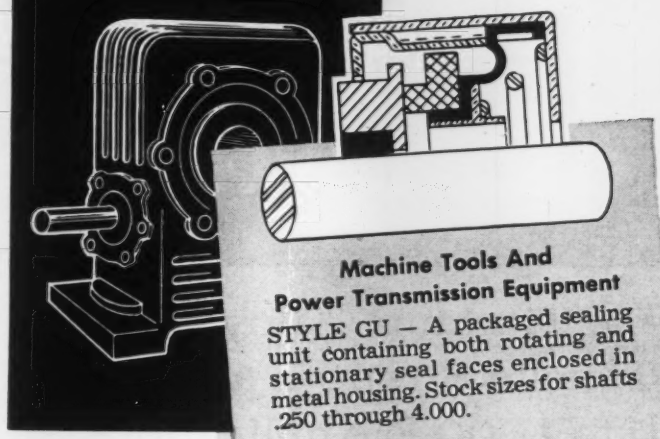
WAGNER "48" SPLIT PHASE MOTORS . . . 1/6, 1/4, 1/3 hp.



for low starting torque requirements

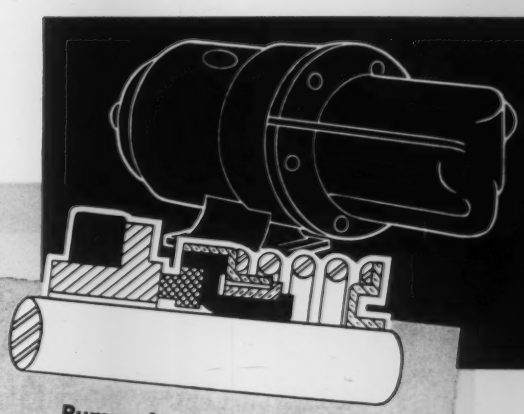
If you need a small fractional horsepower motor for use on fans and blowers or on a wide variety of easy-to-start machines and appliances, you can't beat the Wagner "48" Type RB Motor. It offers all the advantages of the Type RK described above, with the exception of high torque capacitor starting. This smaller, lighter, limited use motor can solve many application problems economically.

WM58-8



Machine Tools And Power Transmission Equipment

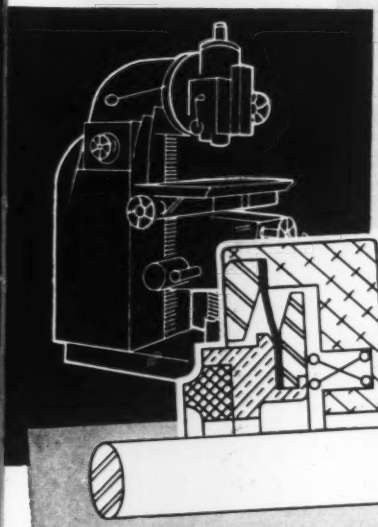
STYLE GU — A packaged sealing unit containing both rotating and stationary seal faces enclosed in metal housing. Stock sizes for shafts .250 through 4.000.



Pumps And Compressors

ROTO-FLEX — Rugged flexibility. Only 3 parts. Single or double units. Stock sizes for shafts .250 through 4.000.

STYLE RFO — A specially designed Roto-flex seal, for installation outside the stuffing box. Stock sizes for shafts .250 through 4.000.



Heavy Machine Tools

STYLE DPC — A high-speed, carbon-faced seal, for more compact installation in heavy industrial machinery. Stock sizes for shafts .250 through 4.000.

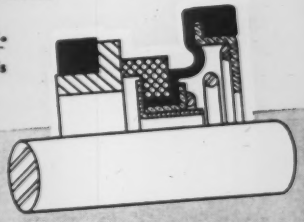
A Complete Line
GITS SHAFT SEALS
For Every Application

These modern, mechanical, face-type seals are carried in stock — to save you time and money. Write for detailed data.

GITS BROS. MFG. CO.

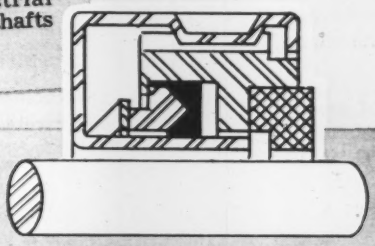
1868-A South Kilbourn Avenue • Chicago 23, Illinois

Specialists In Lubricating Devices And Shaft Seals For Almost Half-A-Century



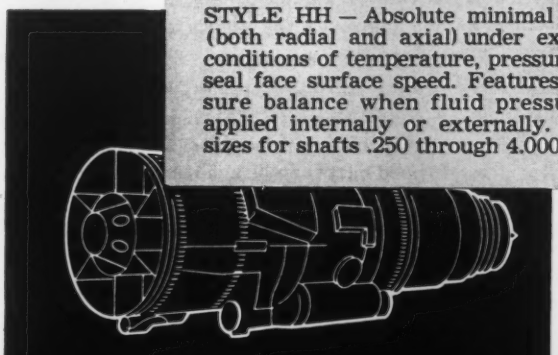
Household Appliances

STYLE SGU—A factory-assembled unit-type seal for the small-budget user. Stock sizes for shafts .250 through 1.000.



Aircraft Engines And Accessories

STYLE HH — Absolute minimal space (both radial and axial) under extreme conditions of temperature, pressure and seal face surface speed. Features pressure balance when fluid pressure is applied internally or externally. Stock sizes for shafts .250 through 4.000.



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Memo on Metals

New Age-hardenable Titanium Alloys Offer Up to 220,000 psi Tensile Strength and Easier Formability for 600 to 1,000 F Applications

Three new age-hardenable titanium alloys may prove to be the solution to many of the strength-weight and temperature problems encountered in designing advanced aircraft and missiles. They may also prove extremely economical for such applications.

All three offer much higher strengths than other titanium alloys – and have the light weight and corrosion resistance typical of titanium alloys. Furthermore, they are readily FORMAGEABLE* – capable of being formed in the solution-treated or "soft" condition and then strengthened by simple thermal aging techniques. Each is now in pilot production and available in limited quantities of mill products.

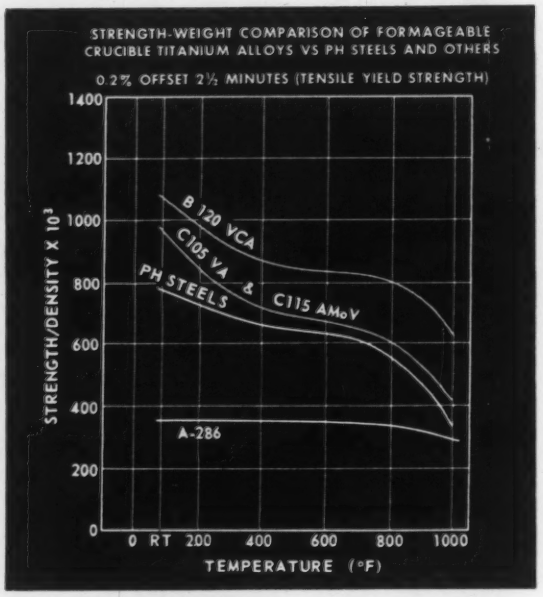
First Age-hardenable All-beta Ti Alloy

Crucible B-120VCA is the first useful titanium alloy with an all-beta (high temperature) structure. It has both the highest strength and best formability of any titanium-base alloy.

This alloy's composition (13%V-11%Cr-3%Al) enables its structure to stay all-beta during forming and/or during slow cooling, and to age to high strength levels at temperatures where distortion is not a problem.

B-120VCA has a unique combination of properties. Room temperature strengths of 200,000 to 250,000 psi have been obtained. On a strength-weight basis this is the highest strength of any available structural material. In short-time elevated temperature tensile tests (1-2 minutes), it offers a decided strength-weight advantage over alternate materials at temperatures up to at least 1,000 F. Under creep conditions, for very long periods of time, it enjoys a strength-weight advantage up to at least 600 F. Beyond this limit, the other Crucible FORMAGEABLE titanium alloys are recommended.

B-120VCA is ductile-weldable, cold-headable, and has great and deep hardenability. Because of this formability, it should prove suitable for applications such as aircraft skins, stiffeners and other primary structural shapes, and for missile pressure tanks, rocket motor cases and structural members. Preliminary tests indicate it may prove unequalled as a construction material for honeycomb assemblies. Because it is so easy to cold-head, it has a large potential in such items as rivets.



Alpha-beta Titanium-base Alloys

Crucible C-105VA is an alph-beta titanium-base material which also is FORMAGEABLE. Its 16% vanadium content stabilizes a sufficient amount of the beta phase for good age-hardenable response; the 2.5% Al content improves the alloy's elevated temperature properties.

C-105VA resolves two conflicting requirements for aircraft sheet material. It is soft, ductile and easily formed in the solution-quenched condition. Because the formed parts can be aged subsequently at moderate temperatures, parts made of C-105VA can possess high strengths at temperatures up to 800 F for long periods of time.

* age-hardenable titanium alloys
* tool steels in production parts
* borated stainless steels

This third alloy, C-115 AMoV (4%Al-3%Mo-1%V), also shows considerable promise for aircraft sheet applications. It is age-hardenable to higher strengths than C-105VA with only slight sacrifice in forming characteristics.

Considerable data on the properties and fabricating qualities of all three alloys have been assembled by Crucible's Titanium Division. For data sheets and additional information, send the coupon.

Tool Steels Replace Standard Alloys for Production Parts

As design and metallurgical engineers require materials with improved properties or greater uniformity, they are turning more to the use of tool steel for production parts. Here are three good examples:

1. Vanes in the hydraulic system that actuates the automatic steering mechanism on cars are made of Crucible REX® M-2 high speed steel. REX M-2 combines the abrasion resistance necessary for minimum wear with the impact resistance needed for long life and safety. The manufacturer experimented with numerous other steels, but high speed steel lasted longer than any other type tested.

2. Actuator bars for a nationally-known calculator are now being produced of Crucible KETOS® – a low-priced AISI Type O1 alloy tool steel – because the thin, close-tolerance contact edges withstood over 4-million high speed blows in a life test. No other steel has lasted more than 1-million cycles before chipping and failing.

3. Cylinder block for a fast acting, aircraft hydraulic pump made of Crucible Chrome tool steel. Pump operates at temperatures up to 500 F, pressures to 5,000 psi. Tool steel was selected over a standard AISI alloy because of its high degree of cleanliness, uniform response to heat treatment, and controlled hardenability. Furthermore, because tool steel practices are employed in making it, the steel more consistently meets the critical mechanical and physical properties required in this application.

For data sheets on these and all other Crucible tool steels – send the coupon.

High Boron Stainless Steels Made Possible by Vacuum Melting

Type 304 stainless steel with boron has proved to be an excellent material for nuclear equipment, because the boron readily absorbs neutrons. By increasing the boron content, valuable weight and thickness reductions can be made in reactor shielding and control rods.

Unfortunately, conventionally melted borated 304 becomes "hot short" – virtually impossible to work if the boron content exceeds 1%. Vacuum melting has provided the answer to this problem. Vacuum-melted 304 stainless is readily workable when the boron content goes up to 2% or even higher.

Vacuum melting the alloy also provides closer control of the composition, because only pure materials are used. So, undesirable elements such as cobalt – which becomes radioactive upon bombardment – can be kept to a minimum. In fact, vacuum-melted Type 304 stainless can be supplied with less than .001% cobalt.

For additional information on vacuum-melted steels – send the coupon.

CRUCIBLE STEEL COMPANY OF AMERICA
Dept. EJ07, The Oliver Building
Mellon Square, Pittsburgh 22, Pa.

Gentlemen:
Please send me the following:

1. Data sheets on B-120VCA ☐ C-105VA ☐ C-115AMoV ☐
2. A copy of "Titanium Alloys for Aircraft and Spacecraft" by Finlay, Vordahl and Malone ☐
3. Data Book on Crucible tool steels ☐
4. Data sheets on vacuum-melted steels ☐

Name_____ Title_____
Company_____
Street_____
City_____ Zone_____ State_____

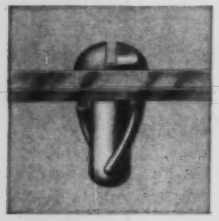
CRUCIBLE STEEL COMPANY OF AMERICA

*Reg. Trade Mark

Circle 469 on Page 19

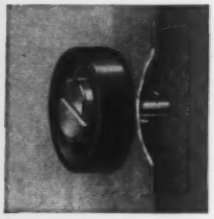
How can you use SPRING-LOCK?

THE FASTENER WITH USES UNLIMITED



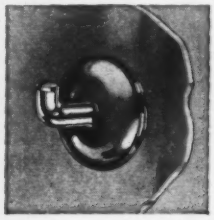
As a standard removable fastener or a blind rivet

A quarter-turn locks, unlocks. Load-carrying steel arms lock securely, don't loosen under vibration. One-piece (no receptacle) simplifies blind fastening.



As a roller axle

Now used on range drawers, kitchen cabinets, file cabinets, desks. Cuts installation costs, saves time. Designed to suit. Available with or without roller.



As cup hooks

High-strength polystyrene or chrome-plated die cast zinc. Inexpensive, sturdy and good-looking. Simply and quickly installed with a twist of the wrist.

As a cabinet door strike

Millions in use on kitchen cabinets, automatic dishwashers, etc. Standard strikes available from stock, or custom designed for special contour requirements.

As a plastic shelf support

. . . with the heart of steel for extra strength. Millions now used by all major refrigerator manufacturers. Complete flexibility of head design.

What is <u>your</u> application for

SPRING-LOCK?

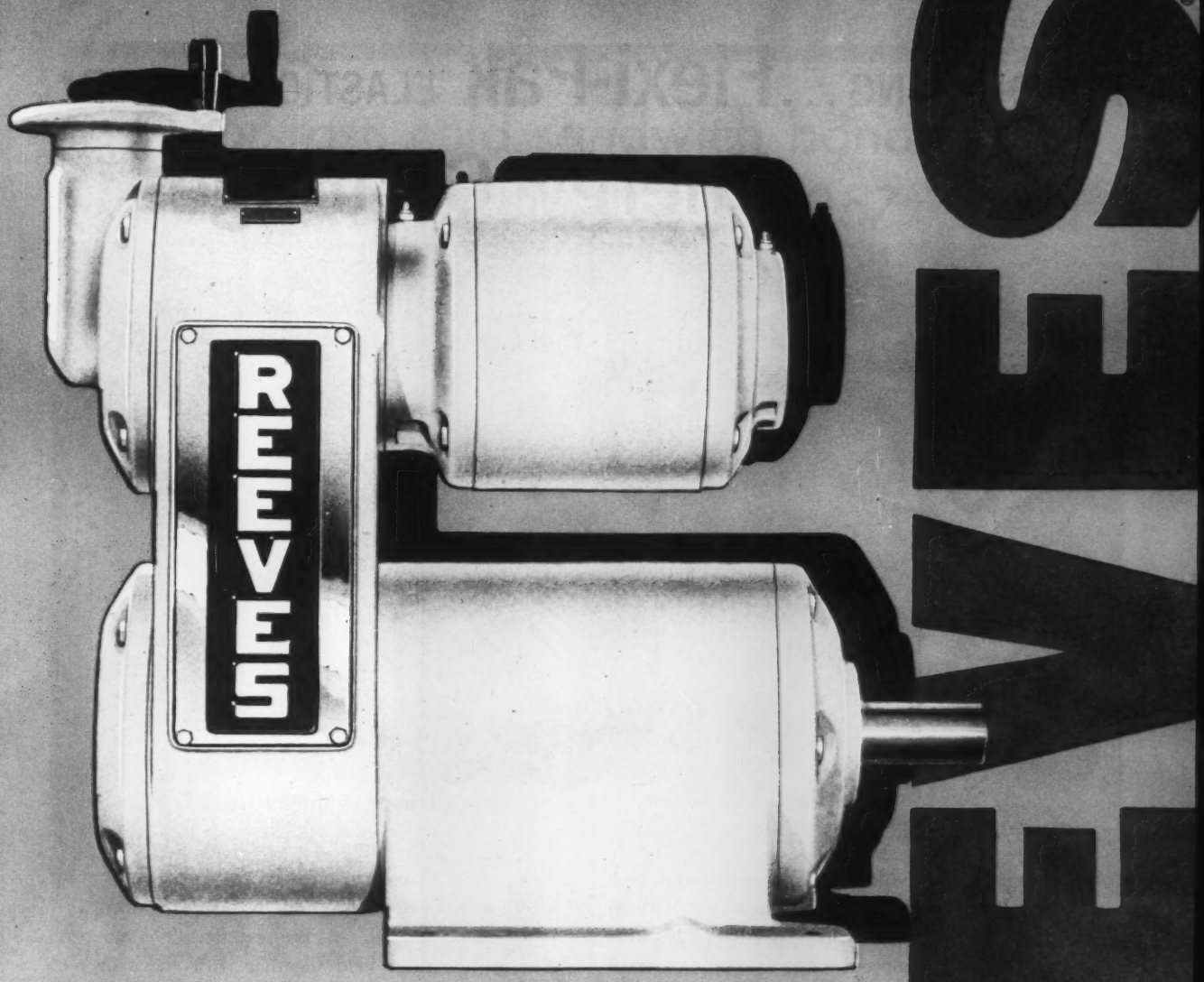
Send us your application inquiries. Our engineers will answer you specifically and promptly. Or, write today for the Simmons Catalog. SPRING-LOCK samples are available upon request.

SIMMONS FASTENER CORPORATION

1756 North Broadway, Albany 1, New York

QUICK-LOCK • SPRING-LOCK • ROTO-LOCK LINK-LOCK • DUAL-LOCK

See our 8-page Catalog in Sweet's Product Design File



REEVES

Sanitary Type

VARI-SPEED MOTODRIVE

● Especially designed for variable speed applications *wherever cleanliness* is a factor. Every sanitary feature has been incorporated: durable white enamel finish; machined mounting surface fits flat; bolt recesses are slanted for drainage; ample cleaning room between motor and reducer housing; no sharp edges; gaskets or seals give moisture protection to the drive at the output shaft, speed indicator and inspection plate; exterior speed seal meets inspection requirements; and special end bells make drive and motor a completely Sanitary Type unit.

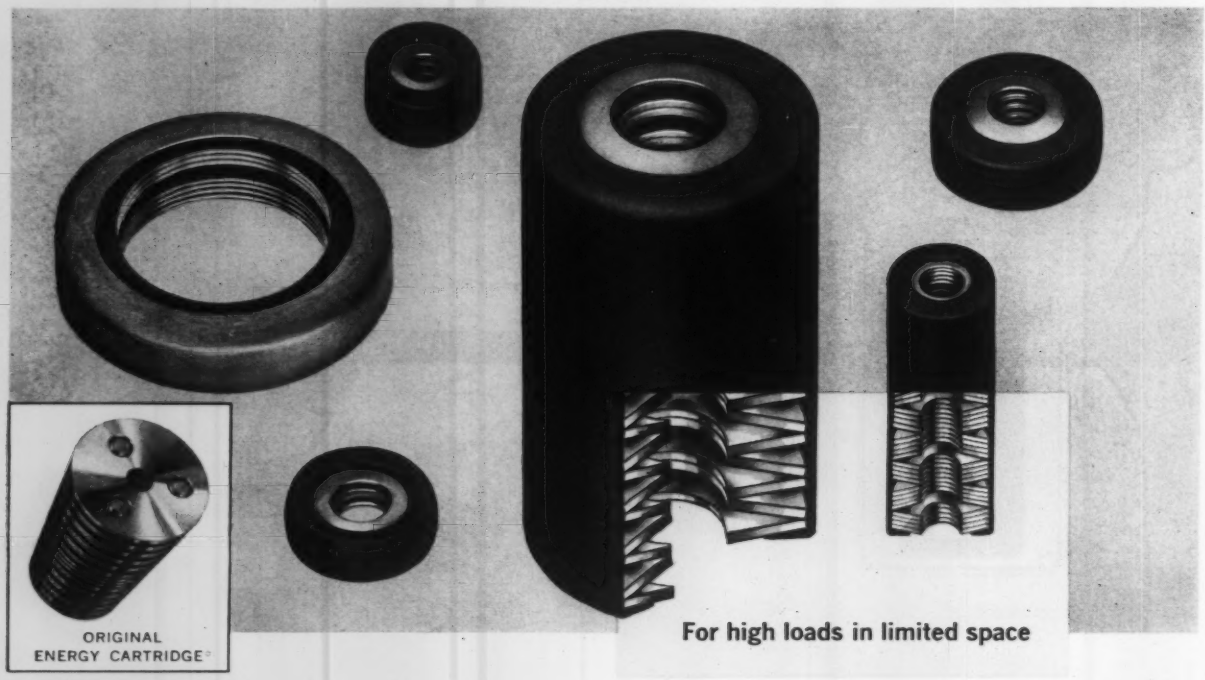
Available in hundreds of assemblies; fractional through 10 hp . . . no reducer, single, double or triple reducer units . . . vertical, 45° or horizontal models . . . "C" or "Z" flow styles . . . and a full range of accessories and manual or automatic controls. For complete details, write for Bulletin H38-M588.

REEVES PULLEY COMPANY • COLUMBUS, INDIANA

DIVISION OF **RELIANCE** ELECTRIC AND ENGINEERING CO. ●

Circle 471 on Page 19

ANNOUNCING... Flexi-Pak ELASTIC-COVERED* Energy Cartridges*



For high loads in limited space

Preassembled belleville spring washers are now available in elastic-covered units in addition to those held together by rivets. Known as Flexi-Pak, molded coverings of rubber, neoprene, or other elastic material can be applied with the washers under tension, or latex coating can be applied under no-load conditions. In either case, washers form integral spring units for applications involving heavy loads in limited space.

Designed for use on washers with narrow walls, or where there are clearance restrictions, the elastic covering insures correct installation or removal of the washers assembled in any sequence. (See cutaway illustration above.) This is especially important where washers are stacked in varying sequence.

As a companion to the previously announced Energy Cartridge held together with rivets or pins through the neutral axis, the elastic-covered units add to the versatility of this increasingly useful type of heavy-duty spring for stripper or die use, machine mounts and drives, constant-force applications, etc.

A.S.C. Divisions are ready to help you use this versatility to advantage with Energy Cartridges tailored to your needs. For more information, write for "Flexi-Pak" folder.

*Patents—Energy Cartridge—U. S. #2,482,449
Elastic-Cover—U. S. #2,432,717

Associated Spring Corporation

General Offices: Bristol, Connecticut

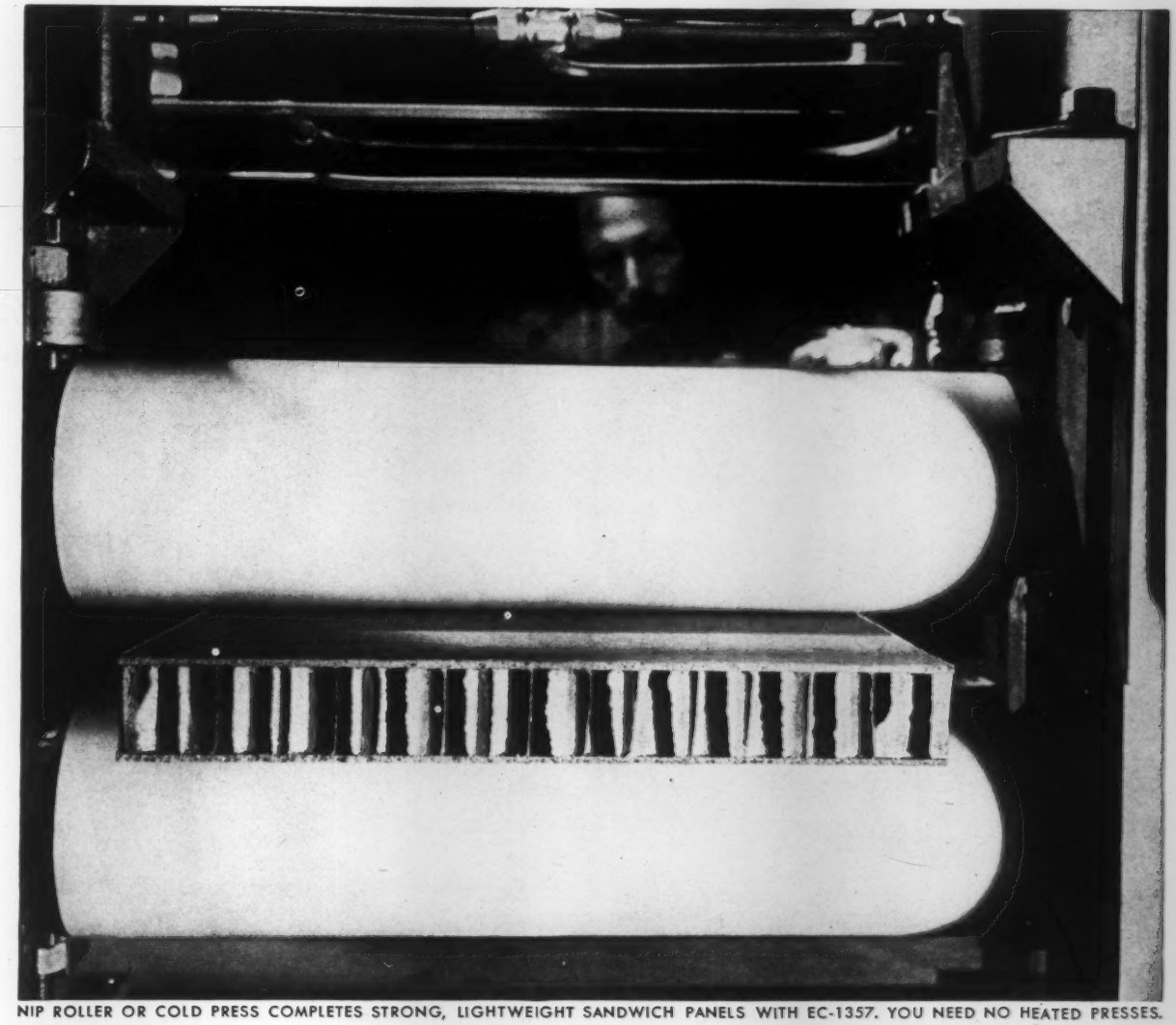
Wallace Barnes Division, Bristol, Conn. and Syracuse, N. Y.
B-G-R Division, Plymouth and Ann Arbor, Mich.
Gibson Division, Chicago 14, Ill.
Milwaukee Division, Milwaukee, Wis.
Raymond Manufacturing Division, Corry, Penna.
Ohio Division, Dayton, Ohio
F. N. Manross and Sons Division, Bristol, Conn.
San Francisco Sales Office, Saratoga, Calif.
Seaboard Pacific Division, Gardena, Calif.
Cleveland Sales Office, Cleveland, Ohio
Dunbar Brothers Division, Bristol, Conn.
Wallace Barnes Steel Division, Bristol, Conn.

Canadian Subsidiary: Wallace Barnes Co., Ltd., Hamilton, Ont. and Montreal, Que. Puerto Rican Subsidiary: Associated Spring of Puerto Rico, Inc., Carolina, P.R.

5834

Circle 472 on Page 19

For fast, cold sandwich bonding ... 3M Adhesive EC-1357



NIP ROLLER OR COLD PRESS COMPLETES STRONG, LIGHTWEIGHT SANDWICH PANELS WITH EC-1357. YOU NEED NO HEATED PRESSES.

Gain the speed and economy of cold bonding! Fabricate sandwich panels for non-load bearing uses with 3M Adhesive EC-1357.

This high-strength, flexible adhesive bonds sandwich panels without clamps or heated presses. You force-dry the solvent out of the adhesive before bonding. Cold press or nip roller finishes the job. You get maximum immediate strength. And EC-1357 builds up even more strength with age as it cures at room temperatures.

Because it is dark in color, EC-1357 absorbs drying heat fast. Thus it cuts production time, allows continuous movement from adhesive spraying to finished panel. EC-1357 resists moisture and normal temperatures, too. For load-bearing panels, investigate 3M Adhesive EC-1177.

SEE WHAT 3M ADHESIVES CAN DO FOR YOU!

Consult 3M research. Contact your 3M Field Engineer. Or for information and free literature, write on your company letterhead to: 3M, Dept. C-10, 417 Piquette Ave., Detroit 2, Mich.

PRODUCT OF 3M COMPANY RESEARCH

MINNESOTA MINING AND MANUFACTURING COMPANY · ADHESIVES AND COATINGS DIVISION

417 PIQUETTE AVE., DETROIT 2, MICH. • GENERAL SALES OFFICES: ST. PAUL 6, MINN. • EXPORT: 99 PARK AVE., N.Y. 16, N.Y. • CANADA: P.O. BOX 757, LONDON, ONT.

Circle 473 on Page 19

It's a Life Saver

because this sensitive

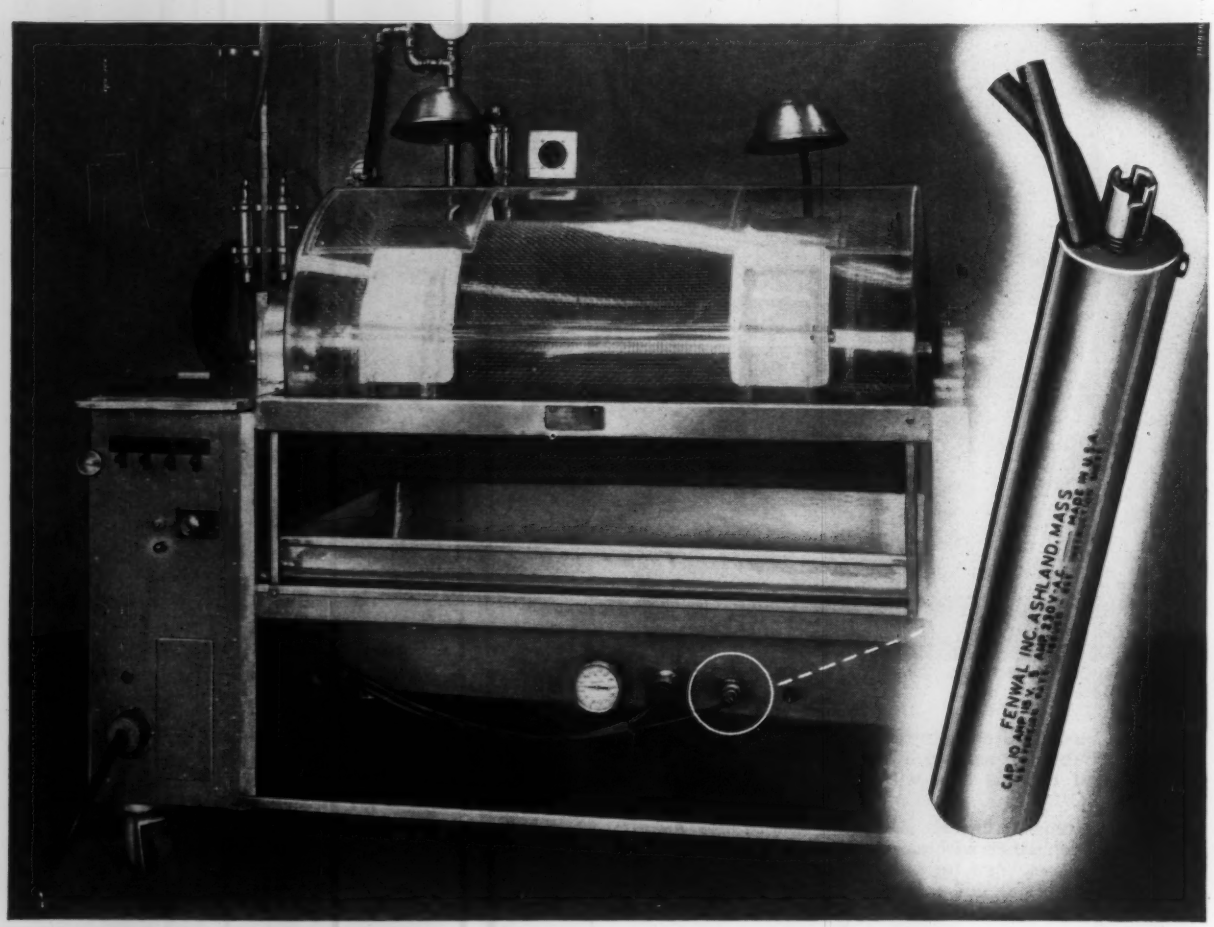
Fenwal THERMOSWITCH® unit controls temperature precisely

Where precise control is necessary, customers have been relying on Fenwal THERMOSWITCH Temperature Controls for years. That's because Fenwal THERMOSWITCH units are extremely sensitive and they last. Consistently they provide one half million cycles or more of precision temperature control. *You get reliability!*

The entire shell is the sensing element of THERMOSWITCH units, giving more heat responsive area and faster reaction to temperature change. This, plus a design based on differential expansion of metals, gives control in fractions of degrees. *You get precision control!*

Fenwal THERMOSWITCH units can help your equipment run faster, require less maintenance, and be more flexible. For information on the model best for your application, write to Fenwal Incorporated, 1910 Pleasant Street, Ashland, Massachusetts, and we'll send you our catalog MC-135 or a sales engineer, whichever you want.

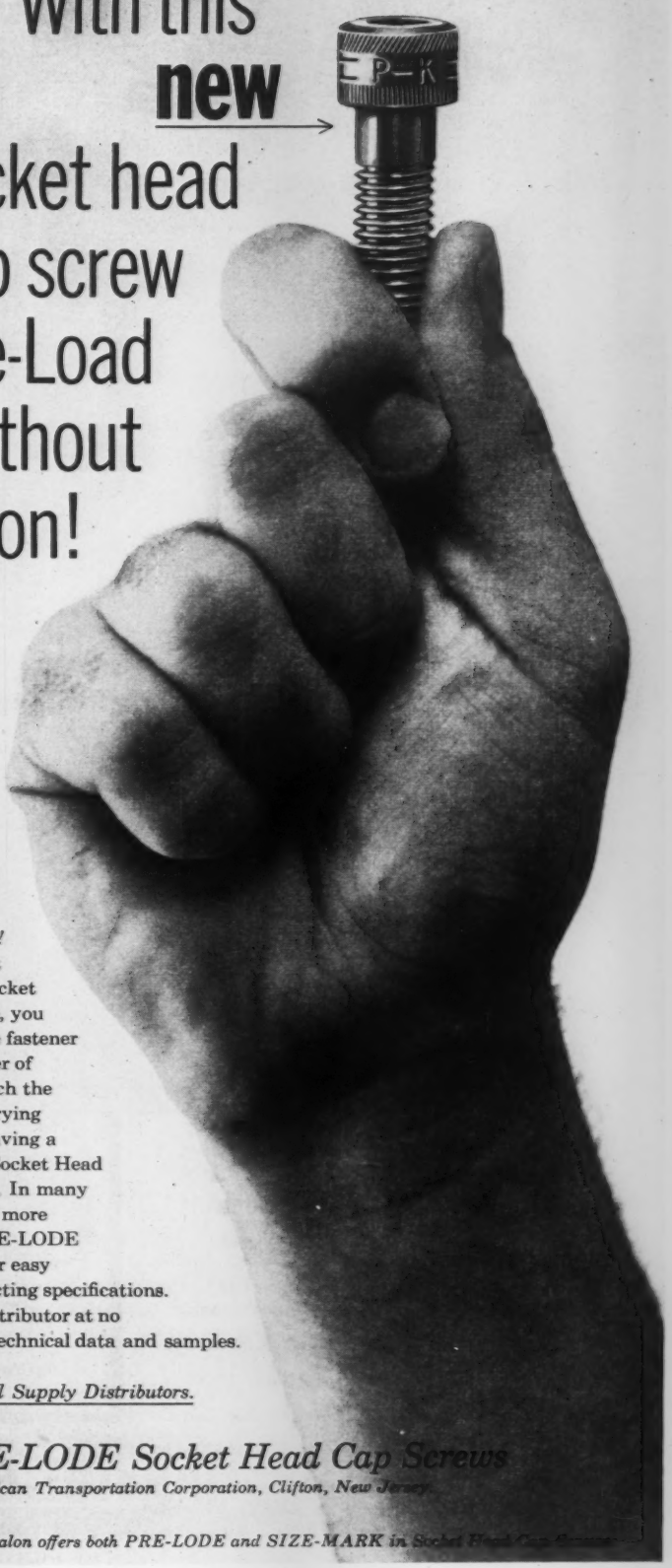
This is our series 17000 in an artificial kidney. This medical equipment has been instrumental in saving the lives of many people suffering from uremic poisoning. Each time the patient's blood passes through the artificial kidney, more poison is filtered out. The Fenwal THERMOSWITCH unit controls the rinsing bath so that blood returns to the patient at body temperature.



Fenwal CONTROLS TEMPERATURE . . . PRECISELY

Circle 474 on Page 19

With this **new** socket head cap screw you can Pre-Load without indentation!



the new P-K® PRE-LODE

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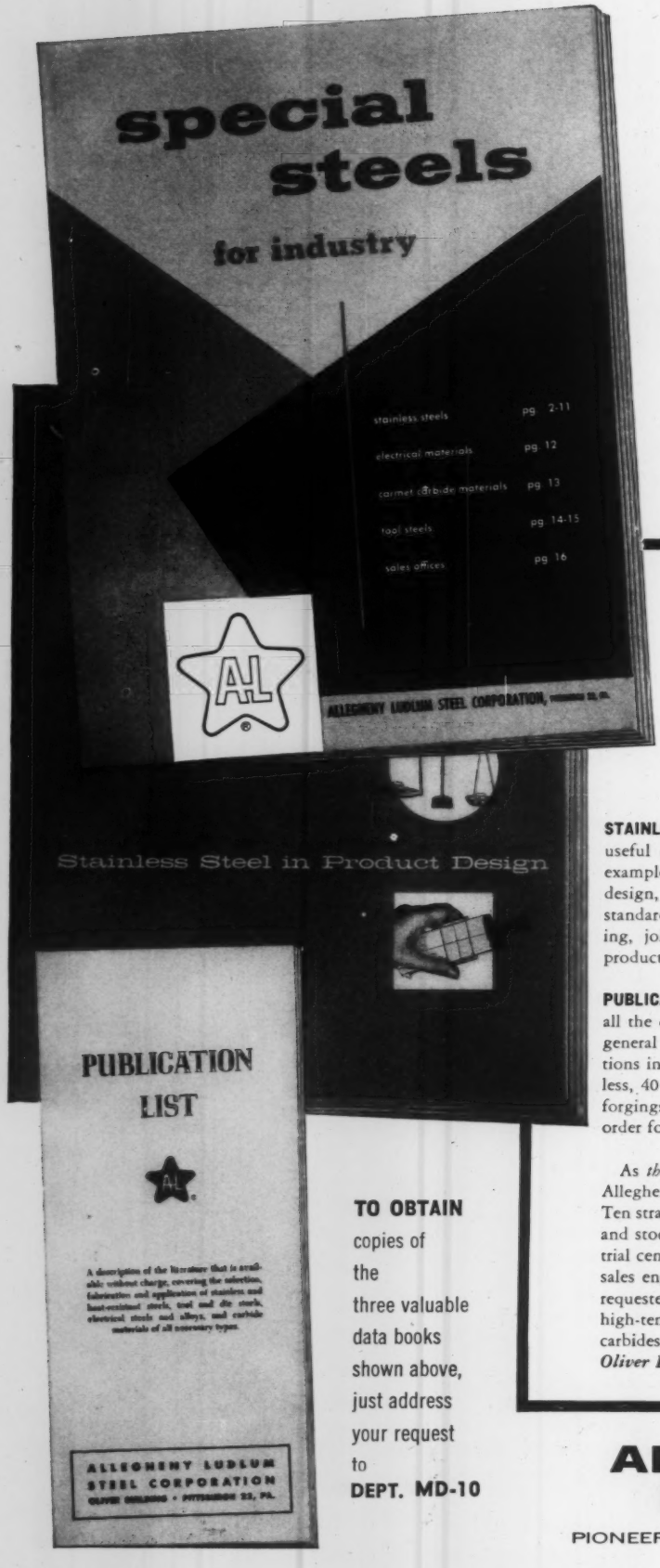
Circle 475 on Page 19



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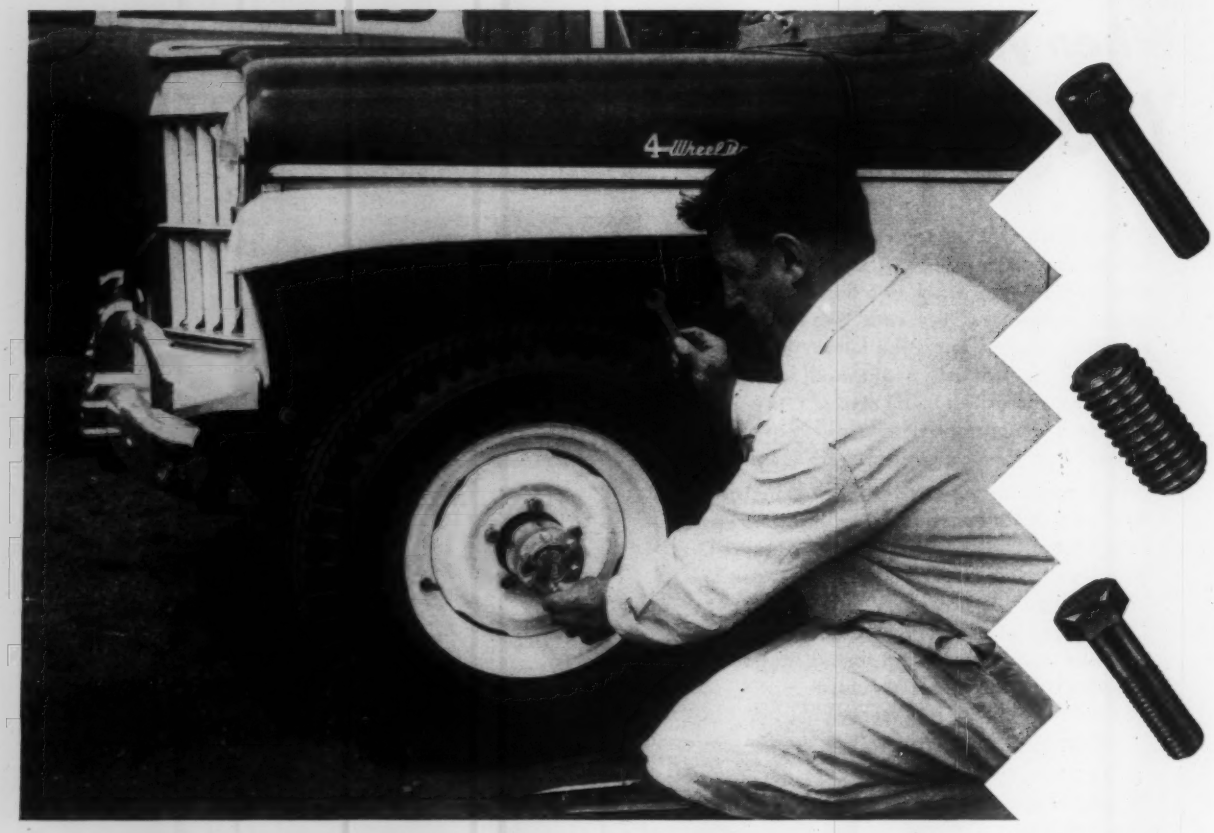
SQUARE D COMPANY

Circle 478 on Page 19

IT PAYS TO STANDARDIZE ON **STANSCREW**



Stanscrew *standard* fastener does *special* job on free-wheeling hubs for "Jeep"

Attaching POWER-LOCK free-wheeling hubs to Willy's 4-wheel drive "Jeeps" calls for something pretty "special" in fasteners.

To begin, the fasteners must be tough and dependable . . . must have the ability to stand up under the punishment that is normal for an "off the road" vehicle. Since these hubs are sold separately, the fasteners also must present an appearance that builds consumer appeal. And they must be completely uniform to facilitate installation.

The Cutlas Tool and Manufacturing Company, Lyons, Ill., manufacturers of this Willys approved accessory, outlined the problem to a Stanscrew fastener specialist. He recommended Stanscrew's heat-treated cap screws with the extra toughness resulting from "Carbon Restoration" . . . cadmium plated for greater consumer appeal and higher corrosion resistance . . . and produced in an unusual length to precisely meet all the requirements for installation on Willy's "Jeep" vehicles.

Thus, by slightly modifying one of the more than 4,000 standard fasteners in Stanscrew's complete line, this specialist was able to supply a fastener which eliminated the necessity for a costly special.

Quite possibly your Stanscrew fastener specialist can do the same for you. He can bring to your problem years of specialized experience, and the services of an outstanding engineering staff. And he can make recommendations from a complete line . . . always in stock, quickly available.

So for the answer to your "special" fastener problem, just call your Stanscrew distributor today. He will arrange for a meeting with the Stanscrew fastener specialist in the very near future.

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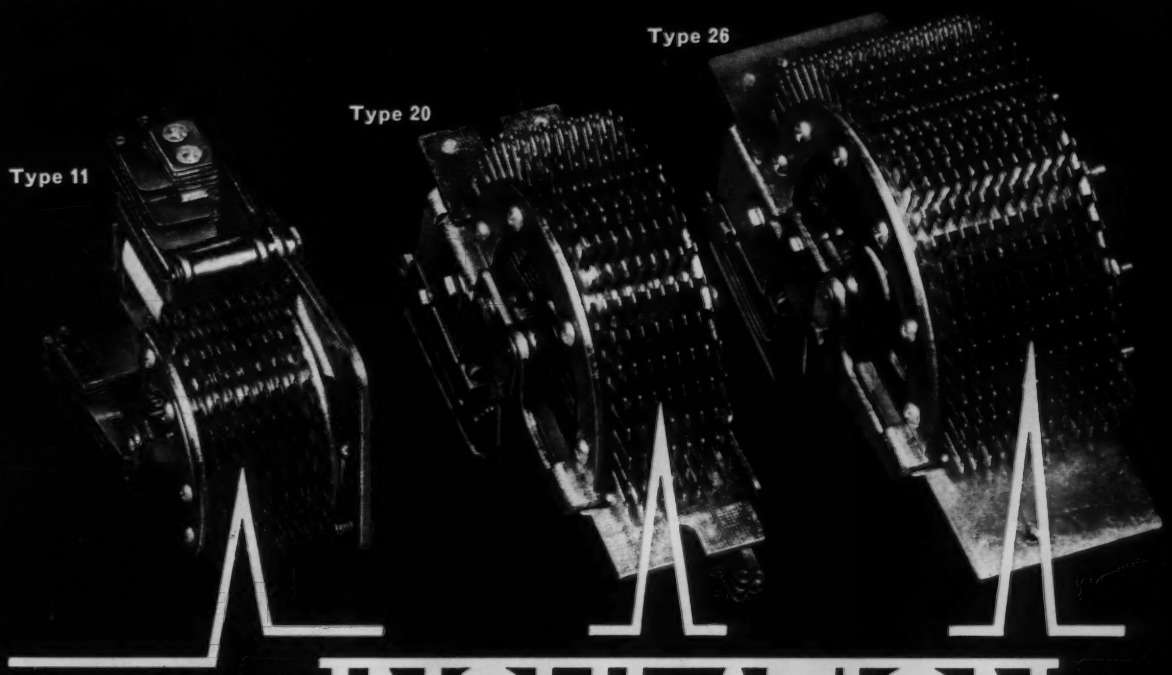

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Circle 480 on Page 19

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14 different tests have proved it now ready for reactor use

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2. Dimension check (using precision measuring instruments)
3. Hydrostatic test
4. Eddy current inspection
5. Tensile and elongation test
6. Rockwell hardness test
7. Flare & flatten test
8. Dye penetrant (over entire length of tube)
9. Metallographic mount (for checking analysis, temper, grain size and structure)
10. Quantitative and qualitative analysis
11. Corrosion tests (Huey, salt spray, Strauss, autoclave, etc.)
12. Spectroscopic examination
13. X-ray inspection
14. Ultrasonic inspection

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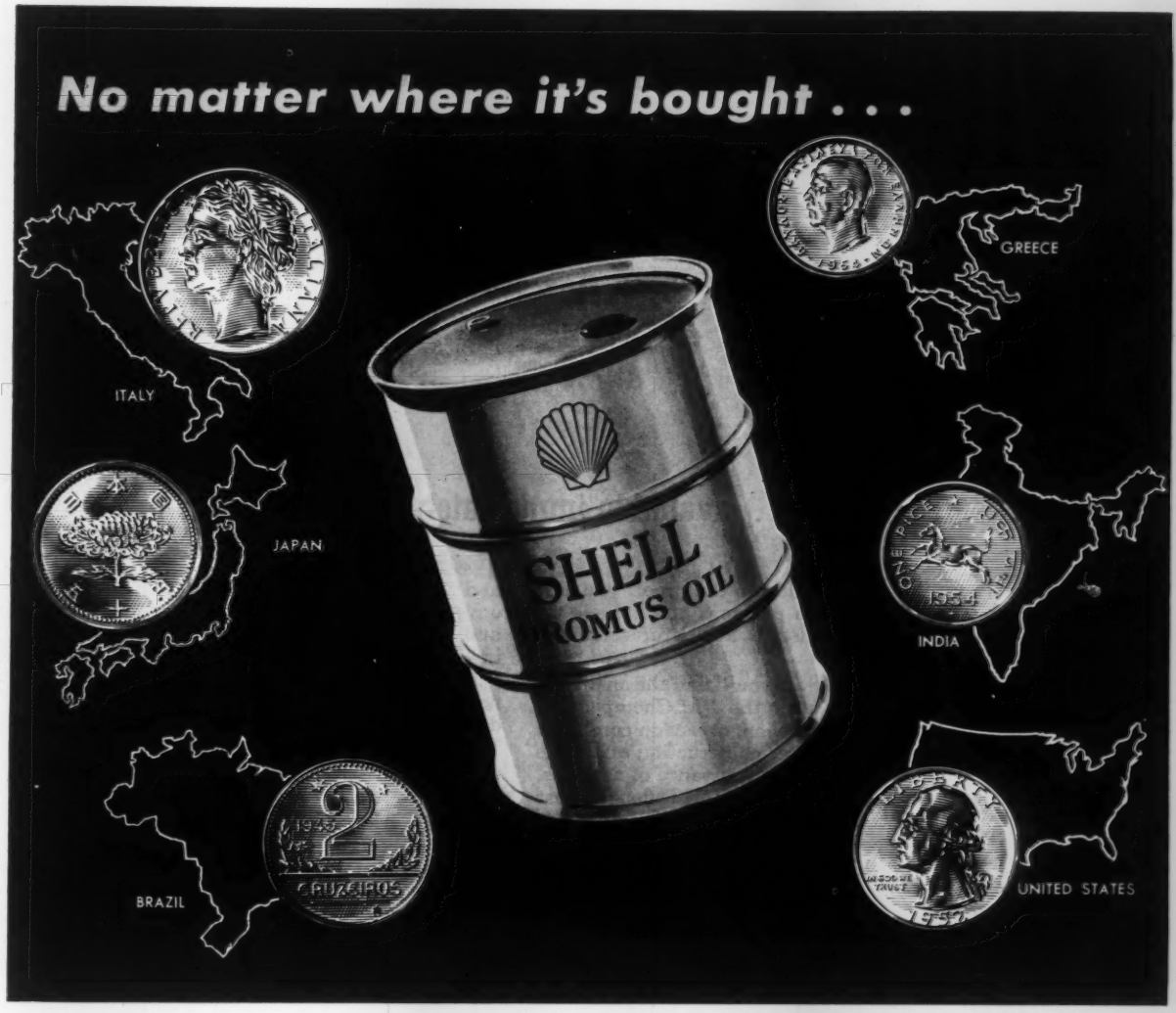

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Circle 482 on Page 19

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They're chemically inert . . . available immediately in the J-M Chempac® line

REPORTS from the field are the proof: you just can't beat J-M Teflon packings and gaskets for resistance to the constant attack of chemicals and solvents!

That's why we say . . . you'll find the answer to any corrosion problem in the J-M Chempac line . . . available in pure Teflon, or Teflon combined with asbestos. The latter construction offers the excellent sealing and heat resistance of asbestos, plus the added protection of Teflon against chemical and solvent action.

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*TM for Dupont Tetrafluorethylene resin

JOHNS-MANVILLE

MACHINE DESIGN

October 16, 1958

Built-In Obsolescence?

HIGH hopes are pinned on the public's acceptance of the 1959-model cars and appliances. Sweeping changes in design will, it is hoped, overcome customer lethargy, persuade consumers to part with their savings, and firmly establish us all on the road to business recovery.

But we sense that in most of the "research" and the "design" decisions, engineers have had a relatively minor voice. Products which are essentially pieces of machinery with clear-cut tasks to perform are being merchandized on the same basis as women's fashions.

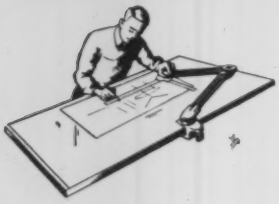
Objective in the design of the latter is to render existing models obsolete as quickly as possible in order to stimulate new sales. The bad part, with engineered products, is that engineers are having to share the blame for this planned obsolescence. For instance, is the poor engineering design that occasionally crops up in cars and appliances wholly due to engineering incompetence? The cynics suggest that engineers have connived at short-cuts which short-change the customer in the interests of saving cost and of hastening the day when replacement will become necessary.

Some of this has helped the popularity of foreign-built cars, a phenomenon which seems to have taken Detroit so much by surprise. It could have been predicted on several counts: Foreign styling design is more stable; the idea of dependable, economical transportation is promoted rather than flashy decoration; European traditions of quality and workmanship are stressed; and customers are offered a variety both in size and design far beyond the limited ranges available in American-built cars. Not to be ignored are the complex social implications of foreign-car ownership.

Despite the foregoing, the buying public seems to share our own belief that U. S. automotive and appliance industries give the consumer the best value for his dollar. Fourteen people buy domestic-built cars for every buyer of a foreign car. Such figures suggest no overwhelming loss of customer confidence—yet. As engineers, let's do all in our power to help retain that confidence—with built-in durability rather than built-in obsolescence.

Colin Carmichael

EDITOR



Source document of engineering drawings and procedures

The Drafting Manual

By R. E. RUCKSTAHL
Manager, Engineering Drawing Office
Air Arm Division
Westinghouse Electric Corp
Baltimore, Md.

Is your problem here?

- **Lack of Drawing Consistency**
- **Misinterpretation of Drawings**
- **Dimensions and Tolerances**
- **Special Tools for Every Design**
- **Repetitive Calculating**

If so, then your answer may lie in this discussion on how to set up and maintain a drafting manual

PROPERLY organized and concisely written, a drafting manual is an enormous aid in the preparation of engineering drawings. It is a source of standards and procedures necessary to produce drawings that transmit the intent of design engineers or draftsmen to the shop or other users. It is a source of standard design data and realistic manufacturing tolerances that help keep fabrication costs down. Granted, such a manual is not easy to prepare. However, the advantages gained from it make the effort worthwhile.

As a source document, the drafting manual must record the decisions and agreements reached between engineering and manufacturing. Items such as drawing procedures, standard drawing callouts, standard designs, and attainable tolerances are of value only when understood and used.

▶ Where Do You Start?

Primary responsibility for the drafting manual should be vested in the drawing office manager. He must be supported by a drawing systems committee, composed of supervisory or advisory personnel from all departments concerned. Drafting, engineering, manufacturing, manufacturing engineering, and quality control should be included in such a committee. This group should review, discuss, and agree on all original material to be included in the manual.

It is important that members of this committee possess the ability to be objective when considering problems confronted by those who make and use the drawings. They must keep in mind that it is a give-and-take proposition. With members of such caliber, and with the proper encouragement from management for the enforcement of standards and procedures, the committee is on a good foundation to build and maintain a useful manual.

▶ What Does It Contain?

The manual should contain information required to carry drawings from original layout through the detail, assembly, and auxiliary drawings. The suggested contents page, shown on the next page, indicates what information should be included in the manual to accomplish this purpose.

Such information is of little value if it cannot

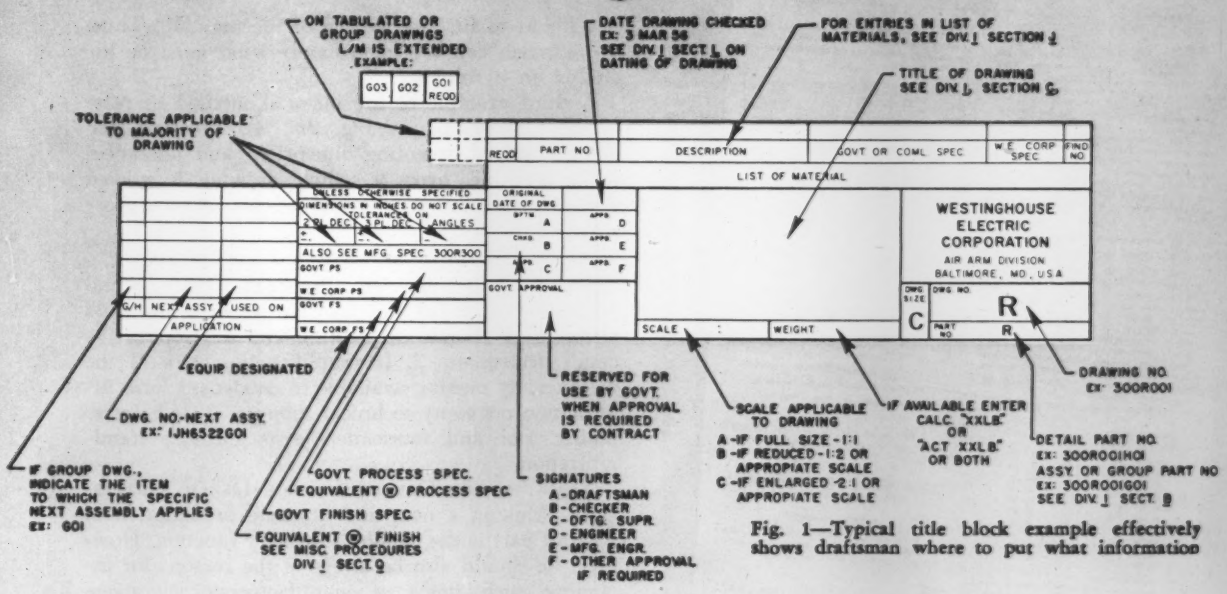

ON TABULATED OR GROUP DRAWINGS L/M IS EXTENDED EXAMPLE:
G03 G02 G01 REQD
DATE DRAWING CHECKED EX: 3 MAR 58 SEE DIV. 1 SECT. 1, ON DATING OF DRAWING
FOR ENTRIES IN LIST OF MATERIALS, SEE DIV. 1 SECTION 4
TITLE OF DRAWING SEE DIV. 1, SECTION 6
TOLERANCE APPLICABLE TO MAJORITY OF DRAWING
REQD PART NO. DESCRIPTION GOVT OR COML. SPEC. W.E. CORP SPEC. FIND NO.
LIST OF MATERIAL
UNLESS OTHERWISE SPECIFIED
DIMENSIONS IN INCHES DO NOT SCALE
TOLERANCES ON
2 PL DEC. 3 PL DEC. ANGLES
ALSO SEE MFG. SPEC. 300R300
GOVT PS
W E CORP PS
GOVT FS
W E CORP FS
G/H NEXT ASSY. USED ON
APPLICATION
ORIGINAL DATE OF DWG.
DFTM A
CHKD. B
ENGR C
APPD. D
APPD. E
APPD. F
GOVT. APPROVAL
WESTINGHOUSE ELECTRIC CORPORATION
AIR ARM DIVISION
BALTIMORE, MD., U.S.A.
DWG SIZE C
DWG. NO. R
PART NO. R
SCALE
WEIGHT
EQUIP DESIGNATED
DWG. NO.-NEXT ASSY. EX: 1JH6522G01
IF GROUP DWG., INDICATE THE ITEM TO WHICH THE SPECIFIC NEXT ASSEMBLY APPLIES EX: G01
GOVT. PROCESS SPEC.
EQUIVALENT Ⓦ PROCESS SPEC.
GOVT FINISH SPEC.
EQUIVALENT Ⓦ FINISH SEE MISC. PROCEDURES DIV. 1 SECT. 9
RESERVED FOR USE BY GOVT. WHEN APPROVAL IS REQUIRED BY CONTRACT
SIGNATURES
A-DRAFTSMAN
B-CHECKER
C-DFTG. SUPR.
D-ENGINEER
E-MFG. ENGR.
F-OTHER APPROVAL IF REQUIRED
SCALE APPLICABLE TO DRAWING
A-IF FULL SIZE-1:1
B-IF REDUCED-1:2 OR APPROPIATE SCALE
C-IF ENLARGED-2:1 OR APPROPIATE SCALE
IF AVAILABLE ENTER CALC. "XXLB" OR "ACT XXLB" OR BOTH
DETAIL PART NO. EX: 300R001H01 ASSY. OR GROUP PART NO EX: 300R001G01 SEE DIV. 1 SECT. 8
DRAWING NO. EX: 300R001

Fig. 1—Typical title block example effectively shows draftsman where to put what information

be found when needed. Consequently, the contents page must be augmented by a comprehensive index which will provide ready access to manual material.

General Drafting Practices: Items included in this section are, for the most part, self-explanatory. They should, however, be chosen with considerable care. The objective is to spell out, in necessary detail, each step in the preparation of a drawing, so that the presentation is consistent from one drawing to the next. Thus, since consistency promotes confidence, manufacturing and quality control will know from previous drawings how the information presented in future drawings should be interpreted. Misinterpretations, arguments over interpretation, rework, and scrap are minimized when quality control and engineering are confident that they are reading and speaking the same language.

PICTORIAL PRESENTATION: Common sense, reinforced by experience, dictates a pictorial presentation as the most efficient method of communicating drafting procedure. An actual titleblock, Fig. 1, illustrates how this method is used. It is possible to write a complete description of the proper entry for each part of the title block. However, the use of the actual title block, reduced to fit onto a page of the manual, is much more effective.

Note that, whenever possible, each entry is fully explained and includes an example. When further explanation is required, the draftsman is referred to another section of the manual where more detailed information is given.

Material specifications on a drawing also lend themselves to pictorial presentation. Once again an actual format, Fig. 2*a*, showing a materials list,

SUGGESTED CONTENTS PAGE

1. General Drafting Practices
   - A. Drawing Format
   - B. Drawing Numbers
   - C. Titles
   - D. Revision of Drawings
   - E. Lettering
   - F. Abbreviations
   - G. Line Conventions
   - H. Projections
   - J. Material Callouts
   - K. Dimensioning
   - L. Methods of Tolerancing
   - M. Dimensioning and Tolerancing
   - N. Types of Drawings
   - P. Manufacturing Tolerances
2. Design Practices
   - A. Machining
   - B. Sheet Metal
   - C. Castings
   - D. Forgings
   - E. Processes and Finishes
   - F. Universal Tools
   - G. Threads
   - H. Gears and Splines
   - J. Riveting
   - K. Welding
   - L. Hardware and Applications
   - M. Tables and Charts
   - N. Springs

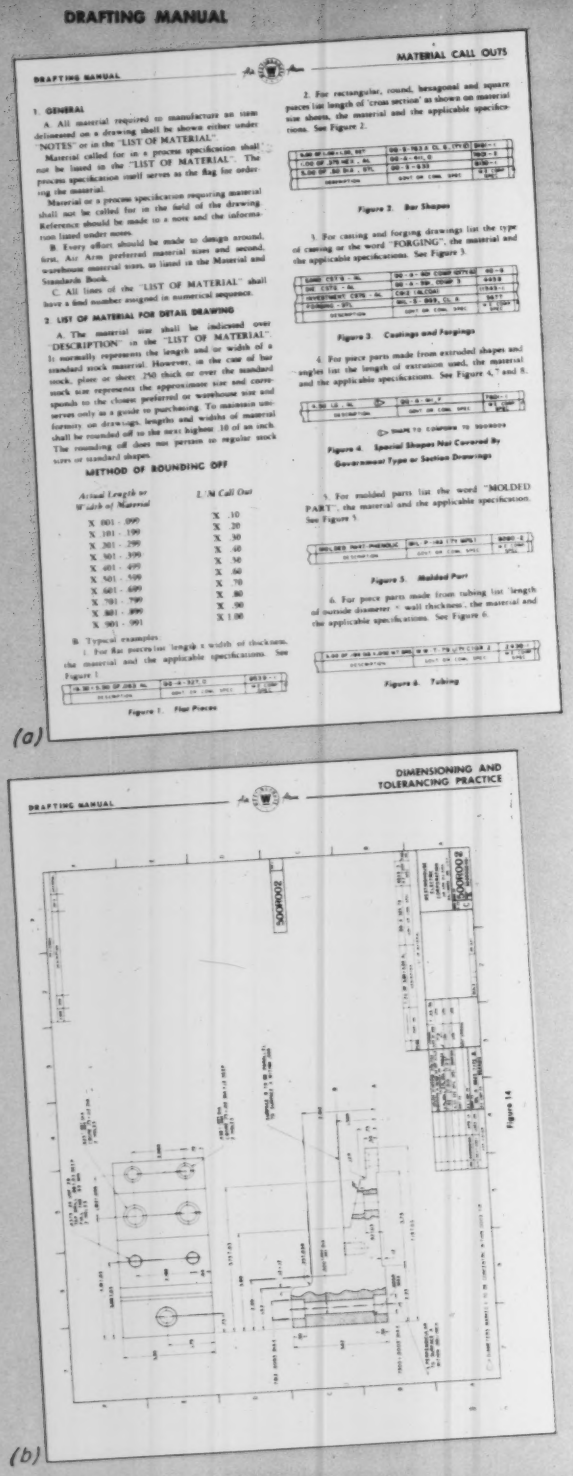


Fig. 2—Pictorial presentations show (*a*) how to call out materials and (*b*) standard dimension notations

is reduced to fit onto a page of the manual. Thus, a draftsman can see immediately what must be included on a drawing.

A third example of the pictorial method of presentation is shown in Fig. 2*b*. To illustrate the proper method of noting dimensions and tolerances for a machined part, a sample drawing is worked up to include as many standard notations as possible.

Recommended Design Practices: This second proposed section of the manual serves a threefold purpose: 1. It aids in training and developing the detail draftsman. 2. It simplifies the work of the designer, by making available in condensed form information on many technical subjects. 3. It helps to reduce tool and fabrication costs through standardization.

TRAINING AND DEVELOPING THE DETAIL DRAFTSMAN: Making a neat and accurate presentation of a detail part is the detailer's primary function. However, he should also be aware of the reasons for including such items as manufacturing tolerances, standardized holes and cutouts, proper bend radii, and finishes. In other words, the detailer should be aware of the meaning behind everything he puts on the drawings.

Use of sample drawings, with additional explanatory information induces detail draftsmen to find out why. For instance, the drawing of a simple sheet-metal bracket, Fig. 3*a*, is augmented with the following information: 1. Recommended minimum tolerances for linear dimensions, and broader tolerances where functionally satisfactory. 2. Recommended dimensioning from the sheared edge wherever possible, and from the bent edge when functional requirements make it necessary. 3. Recommended bend radii, considering material, thickness, and maximum strength. 4. Recommended punched hole sizes wherever possible, providing design requirements are met.

CONSOLIDATING INFORMATION ON TECHNICAL SUBJECTS: Accomplishing such a grouping is not easy, but the benefits accruing to designers makes the effort worthwhile. Designers should co-operate by suggesting additions to this category which would benefit their work, and save time and money.

A sample of condensed information, of value to the designer, is shown in Fig. 3*b*. The American Standard, *Preferred Limits and Fits for Cylindrical Parts*, ASA B4.1-1955, is a complex and extensive compilation of limits and fits, often referred to in designing mechanical equipment. This document was condensed into seven short tables, similar to Fig. 3*b*, to provide the maximum information in the least space.

Gear design is another area in which the designer's time can be saved. Time often wasted in calculating basic gear sizes is eliminated by including tables of basic gear dimensions, in the manual.

REDUCING TOOL AND FABRICATION COSTS: Standard design features such as hole plans, preferred hole and screw-thread sizes, and practical tolerances allow universal tools to be used in manufacturing. Thus costs are reduced.

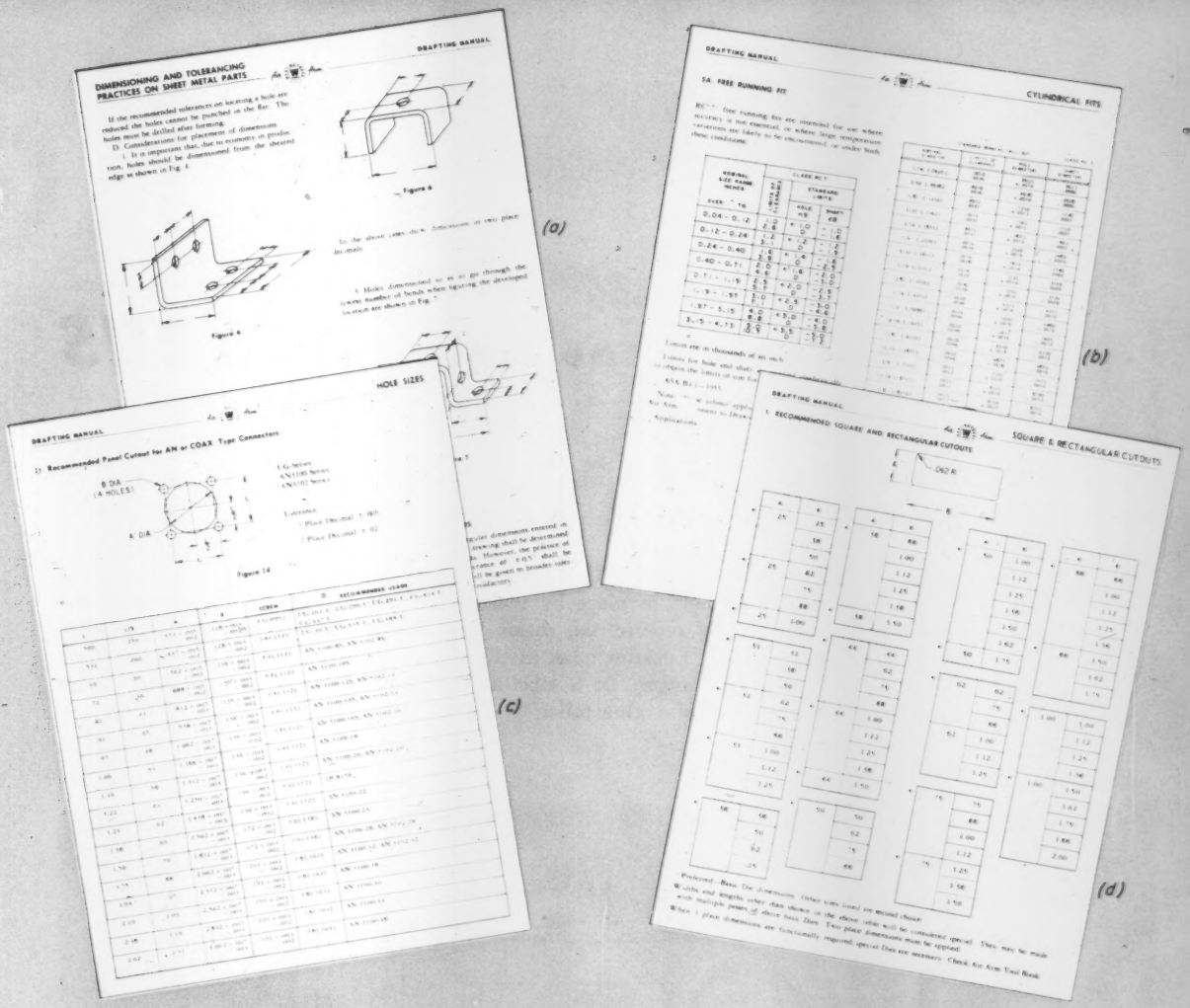


Fig. 3—Recommended practices serve threefold purpose. Illustrated are typical manual pages which (*a*) instruct, (*b*) consolidate information, and (*c*, *d*) help reduce costs

As an example, the standard hole plans, Fig. 3c, for panel cutouts assure the tool department that similar hole plans will be consistently dimensioned and toleranced on all drawings. This enables the tool department to establish a standard cluster or multiple-hole die, and reduces the number of drill and round-punch sizes that must be stocked. Preferred rectangular hole sizes, Fig. 3*d*, reduce the number of standard punches that must be stocked by allowing multiple passes of one punch to produce a series of different size rectangular holes.

Although the foregoing examples illustrate one specific purpose of recommended design practices, each example actually serves all three purposes.

How Is It Maintained?

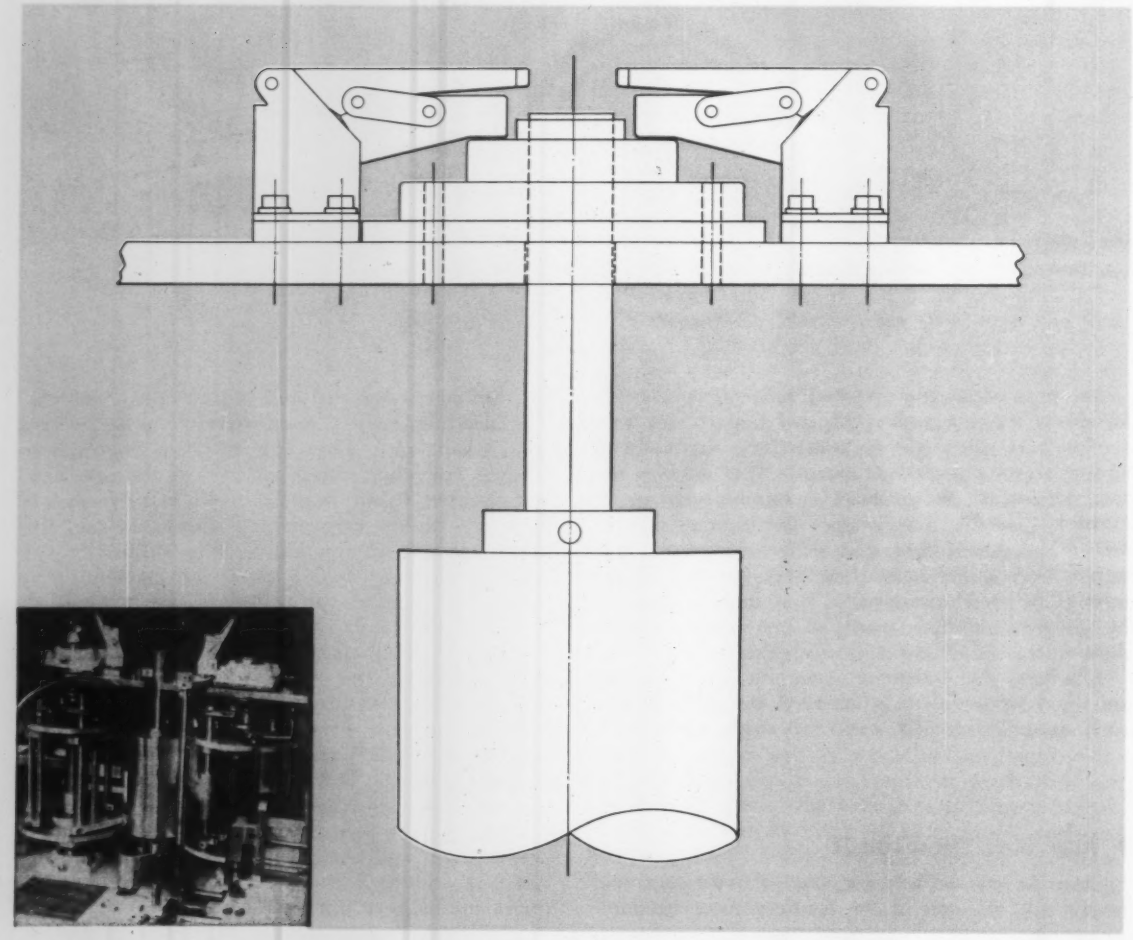
Once the manual is in use, provisions for continual review and revision of the contents must be made to eliminate outdated and unimportant material. The drafting manual is worthwhile only so long as it is kept up to date. It must reflect current procedures and shop processes as well as new data. For example, if the shop acquires a Hydroform type of press, the drafting manual should contain sufficient design information so the draftsman can fully exploit the capabilities of the machine.

Material is never just added to the manual. As in the initial draft, all material must be cleared through the drawing system committee. Also, additions, deletions, and changes must be made in a manner that will preserve the continuity of the manual. In some cases, it is also desirable for the committee to solicit comments from specific manufacturing groups. This collective effort insures support of all groups concerned with the drawings.

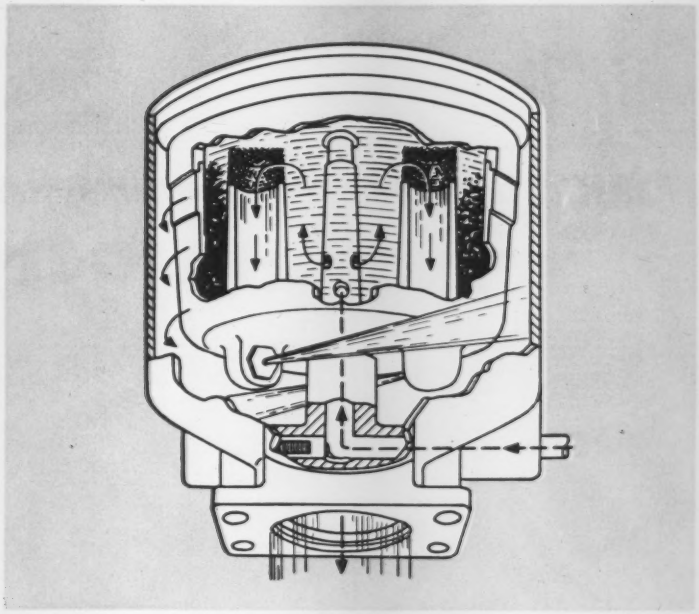
Thus, if the fundamentals of setup, content, presentation, and modification are followed, the result is a drafting manual which correctly transmits intent and helps reduce costs.

scanning the field for *ideas*

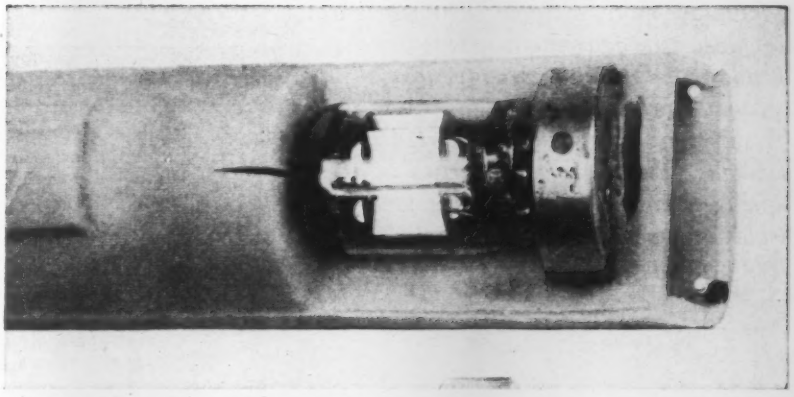
Toggle-clamped bearing permits easy removal of shaft and drum. A flanged bearing, held in place by two toggle clamps, supports the outboard end of the shaft. To remove the drum, the clamps are released and the flange bearing removed. Locating pins in the flange support precisely align and position the bearing flange. In a labeling machine by MRM Co. Inc., the design simplifies removal of a glue roller.

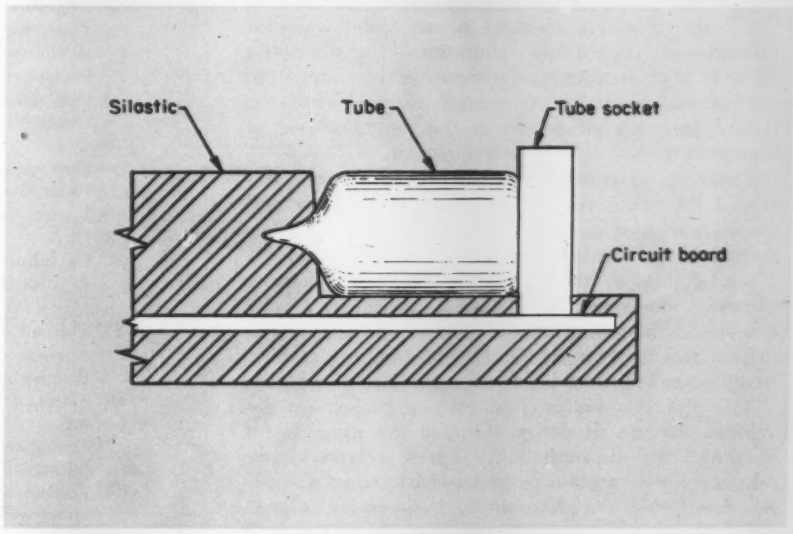


Jet-powered centrifuge filters incoming oil. As oil enters, it is filtered by centrifugal action. Filtration bowl spins because of reaction forces created by filtered oil passing through the high-speed discharge jets. Reported by H. E. Handyside, this design is covered under patents of Glacier Metal Co., Wembly, England.



Partial potting holds and protects electron tube during vibration. Tube is kept from loosening by a cradle of Silastic silicone rubber molded around the top and one side of the tube. A two-piece mold which contains the tube-in-place assembly prevents complete encapsulation of the tube. Flexibility of the potting material permits tube to be easily removed. Design was developed for use in a hydrophone preamplifier by Frank W. Wood Jr, Vitro Laboratories, Division of Vitro Corp. of America.





Elastically supported damper system provides a

New Method for

Conventional spring-damper arrangements can successfully isolate motion in a narrow range of frequencies. However, vibrational environments are becoming more extreme. Problems are increasing as equipment speeds increase. Under such conditions, conventional isolation systems are inadequate.

A solution: Elastically supported damper systems. The unique properties of this spring-damper system make it ideal for isolation over an extremely wide frequency range.

A NEW system for improving vibration isolation places an elastic support in series with the damping element of an isolator. This arrangement essentially eliminates the damping force at high frequency, yet permits the damper to control motion at low frequency ratios. Thus the system performs efficiently in the neighborhood of resonance as well as at high frequencies.

Although knowledge of this type of system has existed for some time, the extent of analysis and the discussion of characteristics of this system, highlighted in this article, are new to the literature.

For simplicity, the elastically supported damper system is analyzed by its application to rigid-body systems. Although structures behave as elastic bodies in practical use, the elimination of damping at high frequencies improves isolation regardless of rigidity.

Through the analysis, parametric curves are developed for use in design. One of the most useful of these, the transmissibility curve, relates transmitted force or motion to impressed force or motion. Another factor, the phase angle, is necessary to completely define the response function. Phase-angle relationships are important in applying isolators to certain servo systems.

This analysis pertains to the system illustrated in Fig. 1*a*. Although the equations and design curves

Nomenclature

$a = a_0 \sin \omega t$ = Displacement excitation of support, in.
c = Viscous damping coefficient, lb-sec/in.
$c' = [(N + 1/N]^2 c$ = Viscous damping coefficient, lb-sec/in.
$c_c = 2m\omega_0$ = Critical viscous damping coefficient, lb-sec/in.
$F_T = F_{T0} \sin (\omega t - \theta)$ = Force transmitted to support, lb
k = Stiffness of main support spring, lb/in.
k_1 = Stiffness of spring in series with damper, lb/in.
k_2, k_3 = Spring stiffness, lb/in.
m = Mass of supported body, lb-sec^2/in.
$N = k_1/k = k_2/k_3$ = Stiffness ratio
$P = P_0 \sin \omega t$ = Force excitation of mass, lb
T = Transmissibility
t = Time, sec
$x = x_0 \sin (\omega t - \theta)$ = Displacement of mass for displacement excitation, in.
x_1 = Displacement of damper, in.
y = Displacement of mass for force excitation, in.
$\beta = w/w_0$ = Frequency ratio
δ = Displacement of mass relative to support, in.
θ = Phase angle, rad
$\zeta = c/c_c$ = Viscous damping ratio
$\omega_\infty = (\sqrt{N + 1})\ \omega_0$ = Natural angular frequency for infinite damping, rad/sec
ω = Angular frequency of excitation, rad/sec
$\omega_0 = \sqrt{k/m}$ = Undamped natural frequency

The following subscripts and superscripts refer to

A = Absolute motion
R = Relative motion
0 = Amplitude of harmonic variation or zero damping
op = Optimum value
∞ = Infinite damping
$*$ = Particular value at common transmissibility point

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VIBRATION ISOLATION

presented are for this system, similar ones can be developed for any of the systems in Fig. 1. In addition, the solutions for any of the systems shown can be obtained by substituting the proper parameters from Fig. 1 into the equations developed here.

System Analysis

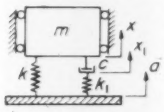
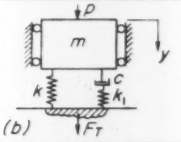
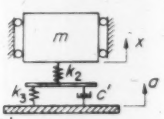
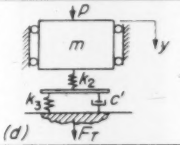
The elastically supported damper system, Fig. 1*a*, consists of a mass supported by a main load spring attached to the base. Constraint of the mass permits movement in only one direction. The base is excited so that its displacement varies harmonically with time. Motion of the mass is damped by a viscous damper supported by an elastic member attached to the base.

Motion: Two equations of equilibrium can be written for this system, one for the mass (see Nomenclature),

$$-k(x-a)-c(\dot{x}-\dot{x}_1)=m\ddot{x} \qquad (1)$$

and one for the combination of damper and spring

Fig. 1—Equivalent Parameters for Elastically Supported Damper Systems

Parameter / System	N	ζ	β	T_A	T_R
 (a)	$\frac{k_1}{k}$	$\frac{c}{2\sqrt{km}}$	$\frac{\omega}{\sqrt{k/m}}$	$\left\lvert\frac{x_0}{a_0}\right\rvert$	$\left\lvert\frac{\delta_0}{a_0}\right\rvert$
 (b)	$\frac{k_1}{k}$	$\frac{c}{2\sqrt{km}}$	$\frac{\omega}{\sqrt{k/m}}$	$\left\lvert\frac{F_{T0}}{P_0}\right\rvert$	—
 (c)	$\frac{k_2}{k_3}$	$\frac{c'\left(\frac{N}{N+1}\right)^2}{2\sqrt{\frac{k_2k_3m}{k_2+k_3}}}$	$\frac{\omega}{\sqrt{\frac{k_2k_3}{(k_2+k_3)m}}}$	$\left\lvert\frac{x_0}{a_0}\right\rvert$	$\left\lvert\frac{\delta_0}{a_0}\right\rvert$
 (d)	$\frac{k_2}{k_3}$	$\frac{c'\left(\frac{N}{N+1}\right)^2}{2\sqrt{\frac{k_2k_3m}{k_2+k_3}}}$	$\frac{\omega}{\sqrt{\frac{k_2k_3}{(k_2+k_3)m}}}$	$\left\lvert\frac{F_{T0}}{P_0}\right\rvert$	—

in series,

$$-Nk(x_1 - a) + c(\dot{x} - \dot{x}_1) = 0 \qquad (2)$$

The equation of motion for this system is written by eliminating x_1 from Equations 1 and 2*:

$$\frac{mc}{kN}\dddot{x} + m\ddot{x} + c\left(\frac{N+1}{N}\right)\dot{x} + kx = c\left(\frac{N+1}{N}\right)\dot{a} + ka \qquad (3)$$

Solution of this equation gives the absolute motion, x, of the mass in terms of the input motion, a.

An equation for the relative motion of the mass with respect to the base is obtained by rewriting Equation 3 and letting $\delta = x - a$:

$$\frac{mc}{kN}\dddot{\delta} + m\ddot{\delta} + c\left(\frac{N+1}{N}\right)\dot{\delta} + k\delta = -\frac{mc}{kN}\dddot{a} - m\ddot{a} \qquad (4)$$

Design Parameters: Transmissibility of this system can be expressed two ways. Solution of Equation 3 results in the following expression for absolute transmissibility,

$$T_A = \sqrt{\frac{1 + 4\left(\frac{N+1}{N}\right)^2 \delta^2 \beta^2}{(1-\beta^2)^2 + \frac{4}{N^2}\zeta^2\beta^2(N+1-\beta^2)^2}} \qquad (5)$$

while solution of Equation 4 gives the expression for relative transmissibility:

$$T_R = \sqrt{\frac{\beta^4 + \frac{4}{N^2}\zeta^2\beta^6}{(1-\beta^2)^2 + \frac{4}{N^2}\zeta^2\beta^2(N+1-\beta^2)^2}} \qquad (6)$$

*J. E. Ruzicka—"Forced Vibrations in Systems with Elastically Supported Dampers," Master Thesis, Massachusetts Institute of Technology, Cambridge, Mass., 1957.

In these equations, the damping ratio, ζ, and the frequency ratio, β, are dimensionless parameters.

Another important tool in analyzing the isolation properties of this system is the phase angle. This is the angle, θ, by which the motion of the mass lags the motion of the support. It is obtained from

$$\tan\theta = \frac{2\zeta\beta^3}{(1-\beta^2) + \frac{4}{N^2}(N+1)\zeta^2\beta^2(N+1-\beta^2)} \qquad (7)$$

In the preceding analysis, it was assumed that motion was induced by harmonic excitation of the base. Equations can also be written when the mass is force excited. For example, in the force-excited system, Fig. 1*b*, the resulting motion of the mass is given by:

$$\left|\frac{y_0}{P_0/k}\right| = \sqrt{\frac{1 + \frac{4}{N^2}\zeta^2\beta^2}{(1-\beta^2)^2 + \frac{4}{N^2}\zeta^2\beta^2(N+1-\beta^2)^2}} \qquad (8)$$

DAMPING LIMITS: Before discussing these expressions, several conclusions about the system can be drawn. For example, zero viscous damping results in a system which is obviously undamped. Consequently, infinite amplitudes can be expected at resonance. Since the damper can transmit no spring force, resonance occurs at the undamped natural frequency, ω_0.

On the other hand, making the damping infinite corresponds to fastening the damper spring directly to the mass. The system is again effectively undamped and infinite amplitudes occur at resonance. In this case, the total spring stiffness is $(N + 1)k$, and the natural frequency is ω_∞.

Having established these limiting conditions, it

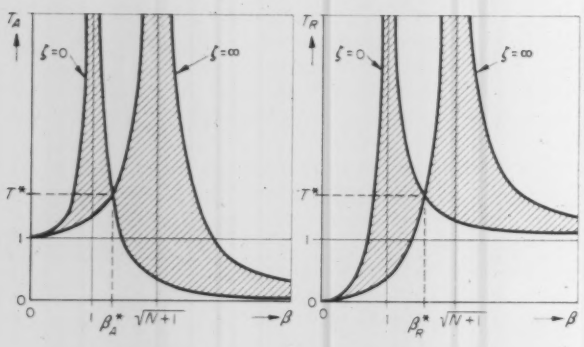


Fig. 2—Transmissibility envelopes. Damping ratios between zero and infinity produce transmissibilities which lie within these curves

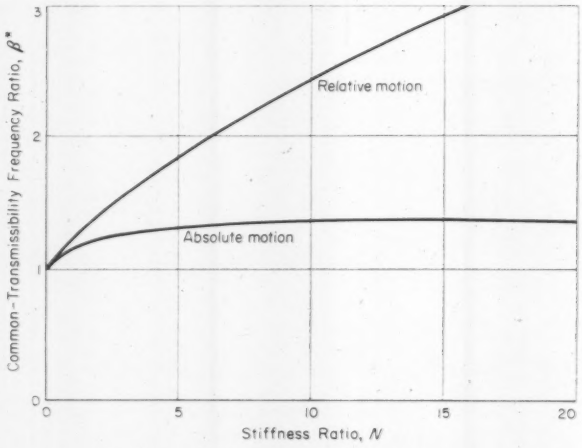


Fig. 3—Common transmissibility frequency ratio. Point at which transmissibility is independent of damping and depends only on stiffness ratio

follows that some value of viscous damping will give a minimum peak amplitude at resonance. This is easily visualized if the viscous damping is increased to a value greater than zero.

Since motion occurs across the damper, some energy is dissipated, and a decrease in the resonant amplitude of the system must result. If this process is continued until infinite damping is enforced, the system again becomes undamped at a higher natural frequency, and infinite amplitudes occur at resonance. Thus, since peak amplitudes vary continuously with changes in viscous damping, there is a value of viscous damping that will produce a minimum resonant amplitude. This value is referred to as *optimum damping*.

It is interesting to note that when N approaches zero, all equations reduce to those for the undamped response of a single-degree-of-freedom system. Also, when N approaches infinity, the system reduces to the classical single-degree-of-freedom system with viscous damping.

Moreover, if the damping is allowed to approach zero, the absolute and relative transmissibility equations become

$$(T_A)_0 = \frac{1}{1 - \beta^2} \tag{9}$$

$$(T_R)_0 = \frac{\beta^2}{1 - \beta^2} \tag{10}$$

The corresponding equations obtained when the damping is made infinite are

$$(T_A)_\infty = \frac{(N + 1)}{(N + 1) - \beta^2} \tag{11}$$

$$(T_R)_\infty = \frac{\beta^2}{(N + 1) - \beta^2} \tag{12}$$

It is evident that Equations 9 through 12 are the envelopes which bound all solutions of Equations 5 and 6.

Common Transmissibility: A plot of absolute and relative transmissibility values for the two undamped conditions, zero and infinite damping, is shown in Fig. 2. The response curve for zero damping intersects the response curve for infinite damping. Since at this point both of the undamped curves have the same transmissibility, the frequency ratio at this intersection is defined as the common-transmissibility frequency ratio. This ratio is found by equating the two transmissibility expressions and solving for the frequency ratio. The proper sign of that portion of the response curve being considered must be taken into account. Thus, the common-transmissibility frequency ratio for absolute motion is

$$\beta_A^* = \sqrt{\frac{2(N + 1)}{N + 2}} \tag{13}$$

and for relative motion is

$$\beta_R^* = \sqrt{\frac{N + 2}{2}} \tag{14}$$

To find the transmissibilities corresponding to these frequency ratios, Equation 13 is substituted in Equation 5, and Equation 14 is substituted in Equation 6. When these substitutions are made, the damping terms disappear in each case, and the common-transmissibility equation results for both absolute and relative motion:

$$T^* = T_A^* = T_R^* = 1 + \frac{2}{N} \tag{15}$$

Since the damping terms disappear at this point, this expression is independent of damping, and all damped curves pass through the common-transmissi-

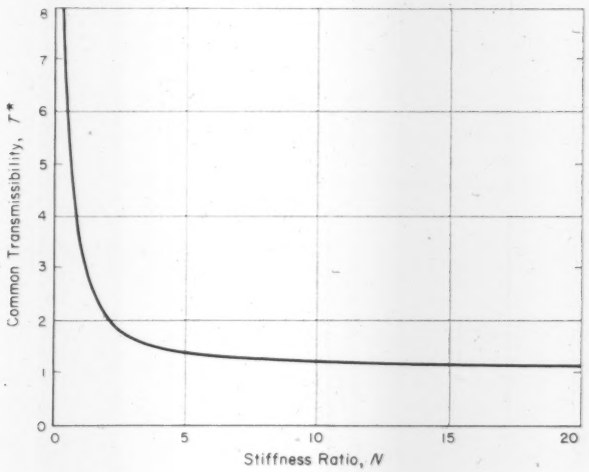


Fig. 4—Common transmissibility versus stiffness ratio. Transmissibility varies from ∞ to 1 as stiffness ratio varies from 0 to ∞

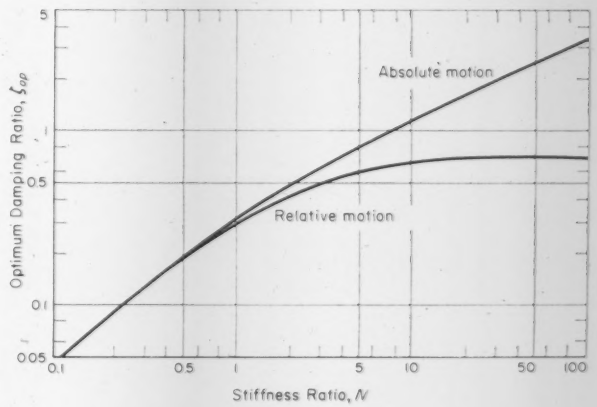


Fig. 5—Optimum damping ratios. The value of damping which produces the lowest resonant transmissibility for a given stiffness ratio

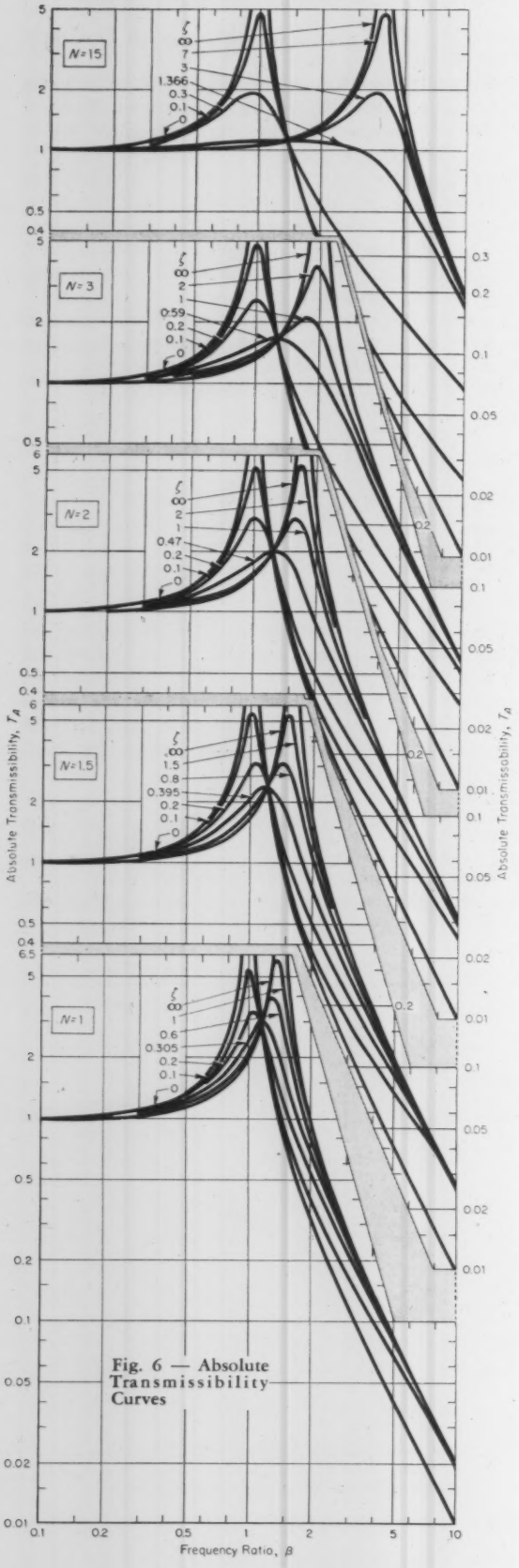
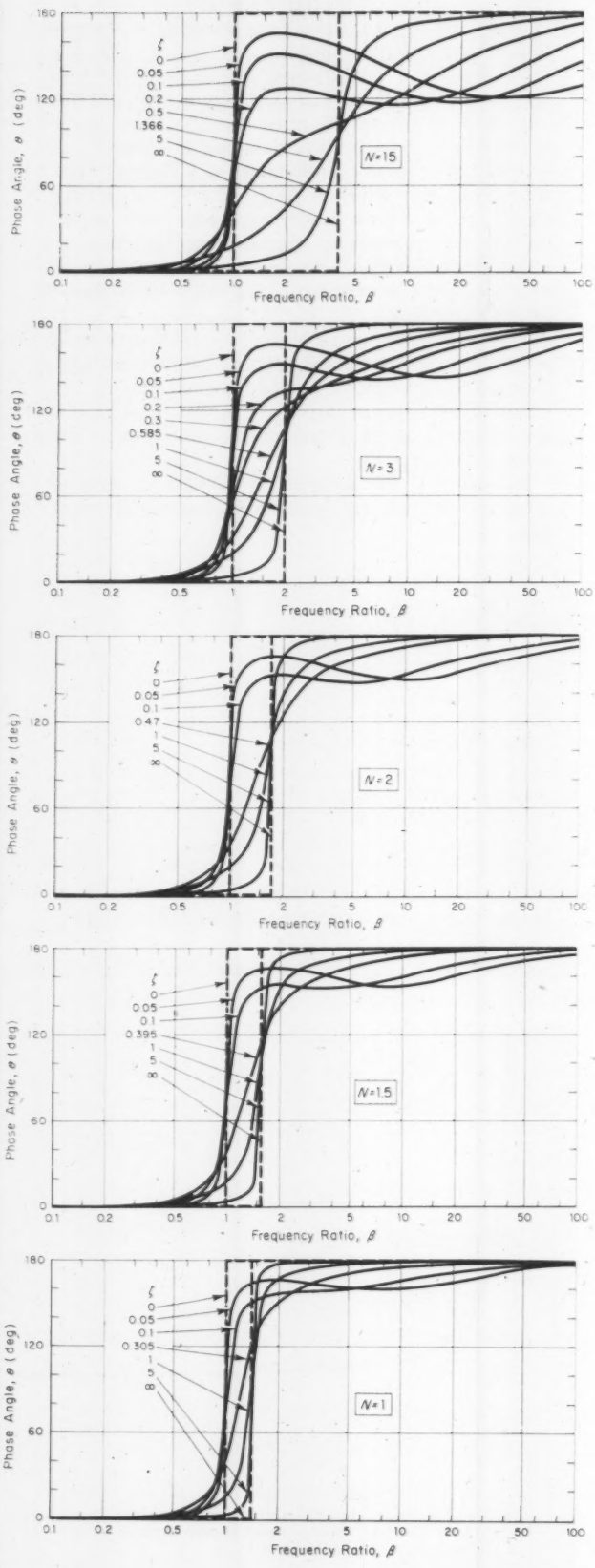


Fig. 6 — Absolute Transmissibility Curves

Fig. 7—Phase Angle Curves



bility point. Note that even though the common-transmissibility frequency ratio is different for absolute and relative motion, the value of the common-transmissibility itself is equal in each case. The common-transmissibility frequency ratio versus the spring-stiffness ratio is illustrated in Fig. 3.

For small spring-stiffness ratios, Fig. 4, the common transmissibility approaches infinity, while for the large ratios, the common transmissibility approaches unity as an asymptote. Thus, for a given value of spring-stiffness ratio, Fig. 3 and 4 give information about the response of the system at a certain frequency ratio for all values of viscous damping. T^* is the minimum-maximum response of a particular system.

Optimum Damping: Within the family of response curves, one curve has its resonant frequency at the common-transmissibility point. That is, the maximum transmissibility of the response curve corresponds to the value of the common transmissibility. The value of damping that characterizes this curve is then the optimum viscous damping coefficient, and the response curve is the optimum-damped response curve.

The value of damping which produces the optimum-response curve for absolute motion is obtained by differentiating Equation 5 with respect to the

Design Example

Design an isolation system having a transmissibility at resonance of $T_{max} \leqq 3$, high-frequency isolation $\leqq 0.025$ at 150 cps, and a mass of 0.1 lb-sec^2/in.

From Fig. 4, if the transmissibility at resonance is to be less than 3, N must be at least 1. To allow a margin of safety, $N = 2$ is chosen. Referring to Fig. 11, the curve for $N = 2$ reaches a value of 0.025 at a frequency ratio of $\beta = \omega/\omega_0 = f/f_0 = 11.0$. Therefore, the natural frequency of the mounting system must be no greater than $f_0 = f/11.0 = 150/11 = 13.6$ cps. A natural frequency of 13.0 cps is assumed.

Since the mass of the system is given, the stiffness of the main support spring is found to be $k = (2\pi f_0)^2 m = (26\pi)^2(0.1) = 668$ lb/in. The stiffness of the damper support spring is then found to be $Nk = (2)(668) = 1336$ lb/in.

Referring to Fig. 5, the damping ratio for the value of $N = 2$ which produces the optimum response curve is $\zeta_{op} = (c/c_c)_{op} = 0.47$. From the definition of c_c, $c = 0.47\ c_c = 0.47\ (2m\omega_0) = (0.47)(2)(0.1)(2\pi)(13) = 7.7$ lb-sec/in.

The isolator design is now complete. If the body were supported on four vibration isolators, one-fourth of the derived stiffness and damping would be needed in each isolator.

Insofar as the damper design tolerances are concerned, Fig. 9 indicates that a variation from -50 to $+100$ per cent in the damping-coefficient design value is permissible without exceeding the specified transmissibility requirement at resonance. These loose tolerances have no effect on the performance of the system in the isolation range.

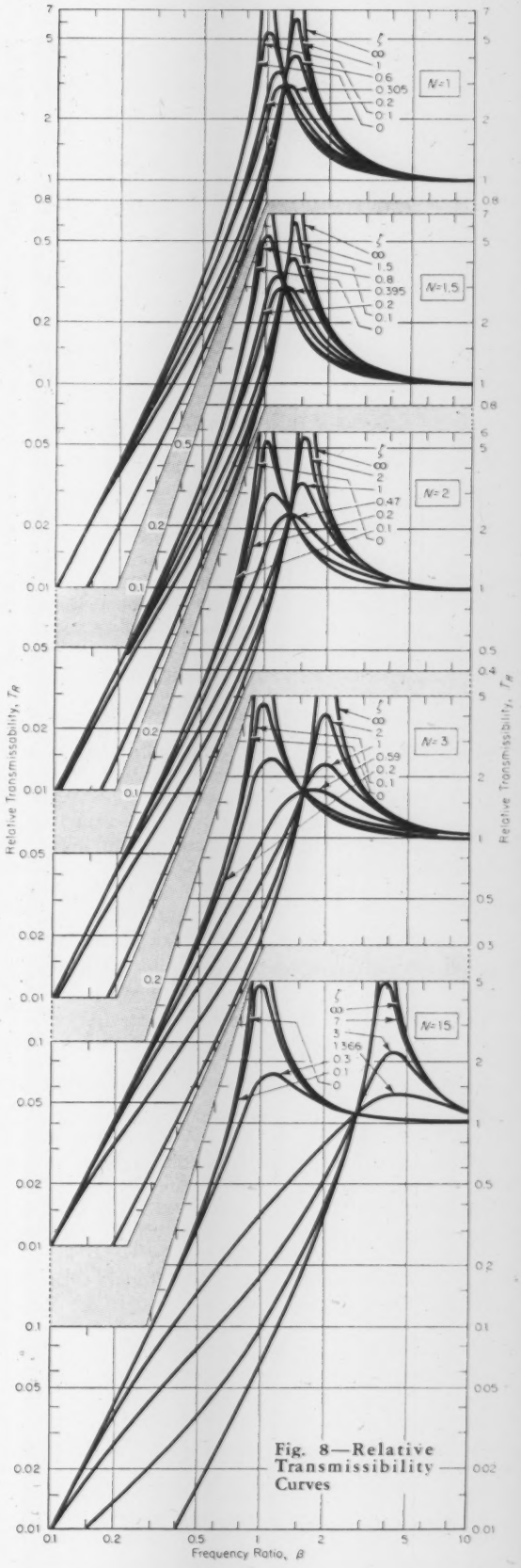


Fig. 8—Relative Transmissibility Curves

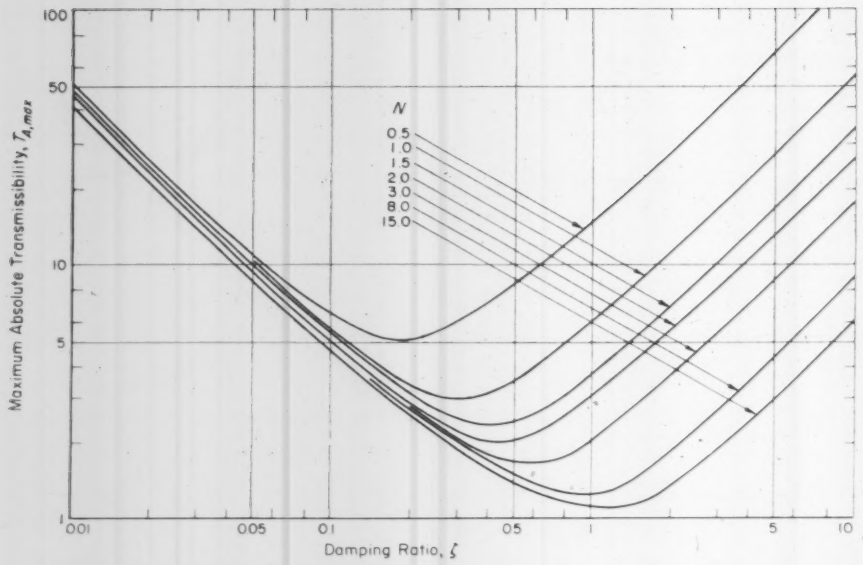
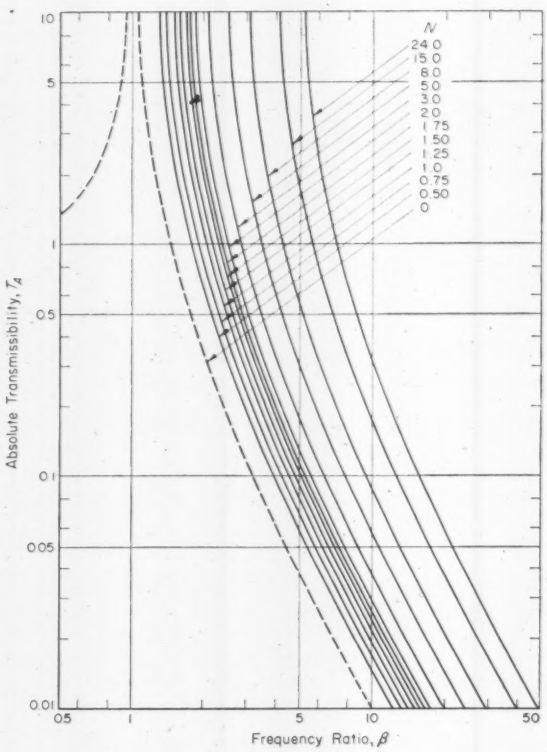


Fig. 9—Family of curves for maximum absolute transmissibility. Damping ratio and stiffness ratio determine curve shapes

Fig. 10—Below—Absolute transmissibilities for infinitely damped systems



frequency ratio and setting the results equal to zero. This equation gives the relationship between the N, ζ, and β at which maximum transmissibility occurs. Since for optimum conditions, this frequency ratio occurs at the common transmissibility point, Equation 13 is substituted in this expression to solve for the optimum-damping ratio as a function of N. Thus, the resulting equation is

$$\zeta_{op./A} = \frac{N}{4(N+1)}\sqrt{2(N+2)} \qquad (16)$$

By a similar procedure, the optimum-damping ratio for relative motion is

$$\zeta_{op./R} = \frac{N}{\sqrt{2(N+1)(N+2)}} \qquad (17)$$

A graph of optimum-damping ratios for both absolute and relative motion is given in Fig. 5.

Transmissibility of the system for large frequency ratios is determined from Equations 5 and 6, by letting the frequency ratio become large, and eliminating terms which are small compared to other terms. The resulting expressions are $T_A = (N + 1)/\beta^2$ and $T_R = 1$. By comparison with Equations 11 and 12, these equations indicate that, for large frequency ratios, the transmissibility of this system approaches that of a system with the damper spring attached directly to the mass. This property is important in problems of vibration isolation.

Typical response curves for five different stiffness ratios are illustrated in Figs. 6 through 8. The curves are plotted for seven damping ratios, one of which corresponds to the optimum condition for absolute motion. From these figures, general trends can be determined which are valuable in visualizing the dynamic performance of the system.

The absolute-transmissibility curves, Fig. 6, show that systems with less than optimum damping respond like directly damped systems at frequency ratios below the common-transmissibility frequency ratio. At frequency ratios somewhat higher than the common-transmissibility frequency ratio, the system responds like an undamped system with a natural frequently of ω_∞.

Range of Application: When damping is greater than optimum, the response curves are similar to those for undamped systems with a resonant frequency of ω_∞, except that the amplitude at resonance is limited. Systems with damping in the vicinity of the optimum value fall within these boundaries.

For low values of N, the shift in phase angle, Fig. 7, from 0 to 180 deg lag, occurs over a relatively

narrow band of frequency ratios. Limits of this band are determined by the values of ω_0 and ω_∞, and the phase lag remains relatively small until a frequency ratio of unity is approached, even for optimum damping. Since phase lag detracts from the overall performance of the servo system, this small phase lag is particularly desirable in isolating servo components whose motion influences the system response. For this reason, the application of the elastically supported damper technique is advantageous in the design of servo components.

Graphs of relative transmissibility have been plotted, Fig. 8, for damping ratios corresponding to those presented in the graphs for absolute motion. Even though none of these response curves correspond to the optimum condition for relative motion, the damping ratio which produces this result can be obtained from Fig. 5. These curves exhibit trends at low frequency ratios similar to those for absolute motion at high frequency ratios.

Variation of the maximum absolute transmissibility with respect to damping ratio has been plotted for various values of N, Fig. 9. The minimum points of these curves represent the optimum value of damping. The curves are relatively flat in this region, indicating that the values of damping required to obtain nearly optimum conditions are not critical. Since temperature sensitivity of damping fluids is a problem, the noncritical nature of damping values is desirable in viscous dampers subjected to wide variations in temperature. This also enables the desired maximum response to be obtained without using the close tolerances usually associated with damping elements.

Fig. 10 illustrates the limiting absolute-transmissibility asymptotes for systems having various values of N. For any particular value of N, regardless of the damping ratio, the response curve must eventually approach the given asymptotic curve at high frequency ratios.

This graph is used to determine a value of N which is compatible with the desired isolation required at a high frequency.

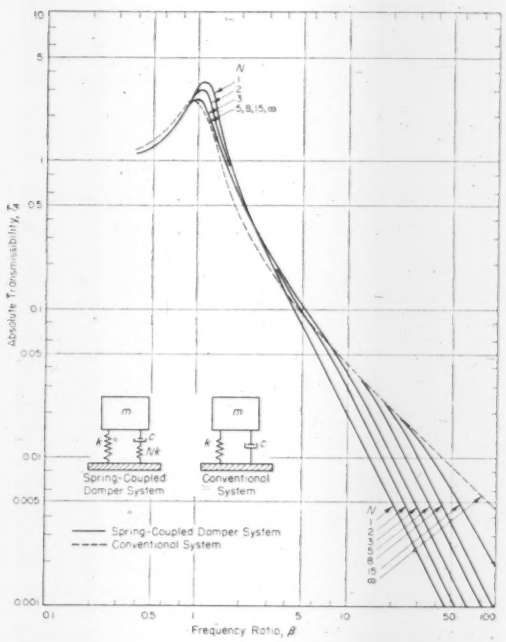
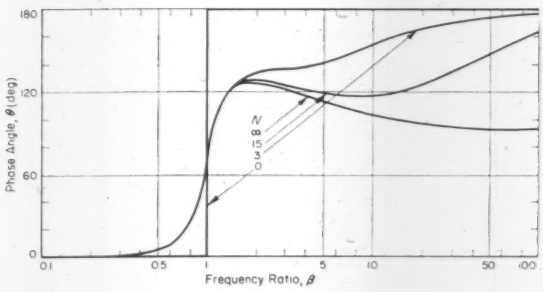


Fig. 11—Response comparison of conventional and elastically supported damper system. Isolation is improved in high-frequency regions with little sacrifice in low areas when elastically mounted damper system is used. High frequency attenuation is 6db per octave for the conventional system, 12 db per octave for elastically supported damper system. Damping ratio is 0.2 for both systems

Fig. 12—Phase angle comparison for various stiffness ratios. Damping ratio is 0.2



Conventional System Comparison

When the response of a directly coupled damper system and that of the system employing an elastically supported damper is compared, the value of the elastically supported damper technique is demonstrated. The response curves of a family of systems, Fig. 11, indicates that little is sacrificed in the performance of the system at resonance, even for small values of N. On the other hand, a substantial gain is achieved in the isolation characteristics.

Referring to the curve $N = 1$, Fig. 11, the peak transmissibility increased from 2.6 for the directly coupled damper system, $N = \infty$, to only 3.35 for the system employing an elastically supported damper. However, the elastically supported damper system improved the isolation by a factor of 20 at a frequency ratio of 100. This condition continues to improve as frequency increases. It should be pointed out that the attenuation rate at high frequency of the conventional system is 6 db per octave whereas the attenuation rate of the elastically supported damper system is 12 db per octave.

The graphical comparison of the phase lag, Fig. 12, indicates that, for the particular condition selected, the difference in the phase lag exhibited by the various systems is negligible below a frequency ratio of unity, except for the $N = 0$ condition. The phase-angle curves for systems having finite values of N tend toward 180 deg. This implies that these systems are essentially undamped. On the other hand, the phase lag of the conventional system, $N = \infty$, tends toward 90 deg, indicating that the damper has detrimental effects on isolation at high frequencies.

Use of the tools developed here is illustrated in the Design Example.

Lost motion in **Precision**

THIS is the concluding part of a two-part article on the causes of backlash in precision gear trains and how to analyze them. Inherent causes of lost motion were covered in Part 1,* while the dynamic aspects of the problem, induced by loads and temperature changes, are discussed here.

Torsional Deflection in Shafts: It is customary practice, in designing instrument gear trains, to guess at the shaft diameters throughout the train. Mistakes are sometimes made which are costly because they are not discovered until a gearbox is in production, tooling is completed, bearings are in stock, and space is at a premium. Changes cause delays and cost money, and in most cases they can be avoided if a more careful analysis is made in the early drafting stage.

A complete analysis of the effect of torsional

* R. H. Wadsworth—"Lost Motion in Precision Gear Trains, Part 1," MACHINE DESIGN, October 2, 1958, pp. 106-110.

EXAMPLE 5

The total velocity ratio for the three-mesh gear train shown in Fig. 5.1 is

$$V = \left(\frac{1.250}{0.125}\right)\left(\frac{1.860}{0.310}\right)\left(\frac{1.860}{0.310}\right) = 360{:}1$$

If the output torque required is 40 oz-in., then the torque on the input shaft will be 40/360, or 0.111 oz-in. Therefore, the torque on the other shafts in the system will be:

$$\text{Shaft } G_2\,P_3 = \left(\frac{1.250}{0.125}\right) 0.111 = 1.110 \text{ oz-in.}$$

$$\text{Shaft } G_4\,P_5 = \left(\frac{1.860}{0.310}\right) 1.110 = 6.660 \text{ oz-in.}$$

$$\text{Output Shaft} = \left(\frac{1.860}{0.310}\right) 6.660 = 40.00 \text{ oz-in.}$$

It should be noted that, although the three shafts are all the same diameter, they transmit greatly different torques.

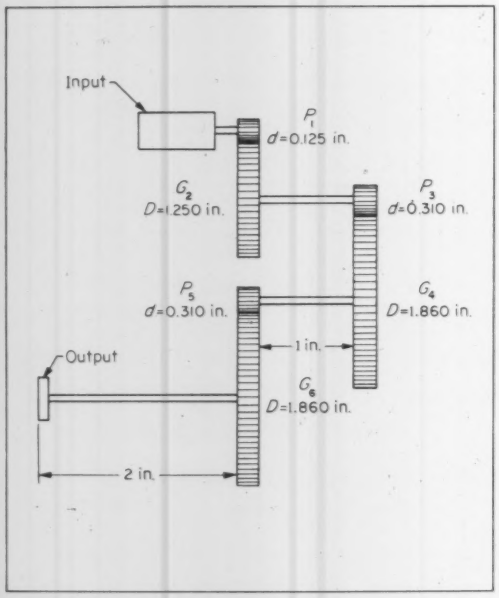


Fig. 5.1—Three-mesh gear train used to transmit torque at the output coupling. All shafts are 3/16 in. diameter

Solution: Since the output shaft transmits the greatest torque, the analysis is started with this shaft. With the output coupling clamped, rated torque is applied to the motor shaft, and the wind-up in the system due to torsional shaft deflection alone is calculated.

The torsional deflection can be found from the expression $\theta = Tl/JG$. To facilitate computation, Fig. 5.2 was prepared from the above formula, with an allowance made for the weakening of the shaft due to taper pins and snap-ring grooves.

The torsional deflection per inch of shaft, between points of torque application, is read opposite the intersection of the torque and the shaft diameter.

In a manner similar to that used in Example 2, the lost motion referred to the drive pinion, due to the angular deflection in each shaft, is listed here in tabular form. The lost motion at P_1 is the product of the referred backlash and the constant 114.59/0.125, and the torsional deflection of the shafts are converted to equivalent backlash by the equation, $B = 2\theta r/114.59$.

Part 2

Gear Trains

By RAYMOND H. WADSWORTH
General Manager
Manhattan Gear and Instrument Co.
Brooklyn, N. Y.

shaft deflection on lost motion at the input pinion of a gear train is outlined in Example 5.

Deflection of Gear Teeth: In trying to reduce the size and weight of gears to meet the demands of miniaturization, it is possible to reach a point where the combination of gear material and face width result in a gear tooth that is not strong enough to withstand the static torque imposed upon it when the train is stopped suddenly by a mechanical detent.

Actual lost motion in the gear train due to tooth deflection during the delivery of running output torque is very difficult to determine and is almost negligble. It is important, however, that no gear tooth be deflected because of inadequate face width. Example 6 has been prepared to answer directly questions dealing with the face width of a specific gear tooth required to transmit a given torque without danger of tooth deflection.

If a change in material is contemplated, the chart

Shaft Number	Torsional Deflection (deg)	Mesh Number	Equivalent Backlash (in.)	Backlash Referred to P_1 (in.)	Lost Motion at P_1 (deg)	Lost Motion at P_1 (% of total)
G_2P_3	0.0025	n-2	0.000027	0.000027	0.03	...
G_1P_5	0.018	n-1	0.00029	0.0012	1.10	1.4
Output	0.216	n	0.0035	0.0846	77.62	98.6
			Total Lost Motion at Pinion		78.75	100.0

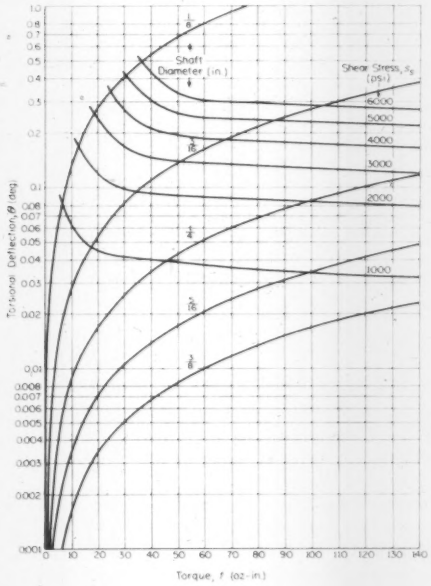


Fig. 5.2—Chart for determination of shaft torsional deflection, and shear stress per inch of shaft. Curves are based on solid-steel shafts with torsional modulus of 12 × 10^6 psi, with allowance made for taper pins and snap-ring grooves

An inspection of the tabular results reveals that an error was made in selecting a 3/16-in. shaft. Fig. 5.2 shows that a 5/16-in. shaft, 2 in. long, would deflect 0.027 deg. This would result in a lost motion of 9.7 deg.

There is one other shaft selection factor which should be considered. As a shaft is twisted, a shearing stress is developed along its cross-section. This shearing stress may be found from, $s_s = Tr/J$.

Lines of constant stress were computed and are plotted on the chart, Fig. 5.2. Examination of the chart reveals that in general, if the shaft is large enough to limit the torsional deflection to acceptable values, the resulting shear stress will be low. Therefore the torsional deflection becomes the limiting factor in instrument shaft design.

Inasmuch as the output shaft is the most critical, the permissible angular twists that will produce a 0.0003 in. lost motion at the pitch circle of the output gears are:

Gear Pitch Diameter, D (in.)	Permitted Angular Twist (deg/in. of shaft)	Gear Pitch Diameter, D (in.)	Permitted Angular Twist (deg/in. of shaft)
0.5	0.068	1.6	0.021
0.6	0.057	1.8	0.019
0.7	0.049	2.0	0.017
0.8	0.043	2.2	0.016
0.9	0.038	2.4	0.014
1.0	0.034	2.6	0.013
1.2	0.029	2.8	0.012
1.4	0.025	3.0	0.011

gives the new required face width. Included are diametral pitches from 32 to 120, torque values from 1 to 140 oz-in., and 12 different materials. The face width read on the chart is the minimum that will cause the tooth to be stressed to its yield stress. If the yield stress is exceeded, there is danger of permanent deformation.

The chart has been designed from the familiar Lewis formula, $f = W_t/s_{yp}pY$, for the strength of a gear tooth under static load. A chart based on

EXAMPLE 6

The minimum face width of a phosphor-bronze gear transmitting a torque of 12 oz-in. is to be determined. It contains 22 teeth with a diametral pitch of 96, and static tooth stress must not exceed the yield stress of the material.

Solution: Fig. 6.1 is used in the following manner. Enter the chart at the torque value, 12 oz-in., and proceed vertically to the proper diagonal diametral pitch line, 96. Then move horizontally until the diagonal, indicating the correct number of teeth, 22, is reached, and drop vertically to the diagonal line which indicates the material being used, phosphor bronze. Move horizontally and read the minimum face width, 0.093 in., on the vertical axis. This then is the face width used to meet the requirements.

The materials indicated on the chart are arranged in order of increasing yield stress. Thus, the farther down the chart the material occurs, the less the face width required.

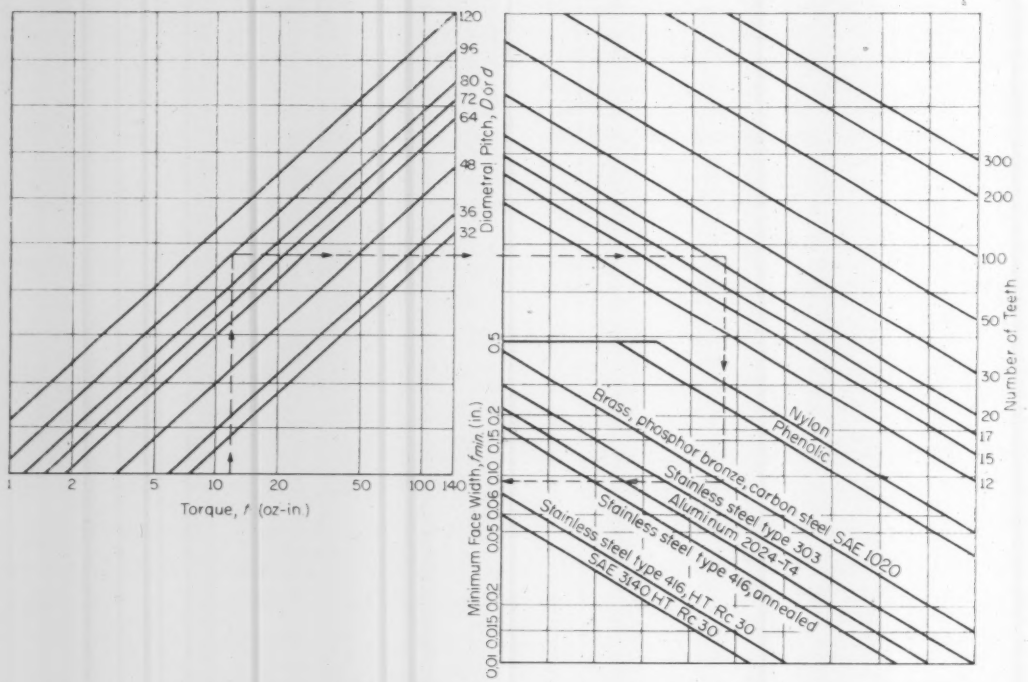


Fig. 6.1—Face width determined for precision gears loaded to yield strength

Nomenclature

B = Backlash, in.
ΔB = Change in backlash, in.
C = Center distance, in.
ΔC = Change in center distance, in.
D = Pitch diameter of gear, in.
d = Pitch diameter of pinion, in.
F = Tangential force, oz
f = Face width, in.
G = Torsional modulus, psi
J = Polar moment of inertia, in.^{4}
l = Length, in.
P = Diametral pitch
p = Circular pitch, in.
R = Pitch radius of gear, in.
r = Radius of shaft, in.
S = Separating force, oz
s_{yp} = Yield stress, psi
s_s = Shearing stress at outer surface of shaft, psi
T = Applied torque, lb-in.
ΔT = Temperature change, deg F or deg C
t = Applied torque, oz-in.
V = Velocity ratio
W_t = Tangential tooth load, lb
x = Pinion rotation, deg
Y = Lewis factor for 20-deg pressure angle involute tooth
α = Coefficient of thermal expansion, in./in./deg F
θ = Pressure angle, deg
ϕ = Angle of twist, deg

a 14½ deg pressure angle is not included here since this pressure angle has largely been superseded by the 20 deg angle for precision instrument gears.

Temperature Change: In the design of gear trains used for aircraft instruments, and particularly those manufactured to government specifications, a temperature range from − 55 to + 85 C is often encountered, calling for satisfactory operation of the gear train over the entire range.

This requirement imposes strict limits upon the designer in the choice of materials for gears and housings. Materials that are ideal from a strength, weight, or machining standpoint are usually not satisfactory from an expansion and contraction standpoint. A tabulation of materials and their coefficients of expansion are given in Table 3. Thus aluminum alloy 356-T6 is widely used for cast gearbox housings, and Type 416 stainless steel for gears, yet the aluminum has an expansion and contraction rate 2.1 times that of the stainless steel. What this can mean to lost motion is illustrated in the analysis of Example 7.

Bearing Loads: It is known from experience that bearings of all types are subject to radial play.

Table 3—Coefficients of Thermal Expansion for Materials

Material	Coefficient of Thermal Expansion, α (in./in./deg F)
Aluminum	
Wrought, 2024-T4	12.9×10^{-6}
Cast, 356-T6	11.9
Aluminum bronze	9.4
Brass	10.2
Bronze	9.9
Cast iron	5.6
Copper	9.3
Magnesium	
Wrought	14.4
Cast	14.9
Phenolic, fabric base	14.0
Phosphor bronze	9.4
Steel	
Cold-rolled, SAE 1020	6.3
Stainless, AISI Type 302, 303	8.0
Stainless, AISI Type 416	5.6
Vanasil	8.4×10^{-6}

EXAMPLE 7

Fig. 7.1 shows stainless-steel gears, journaled in an aluminum-alloy housing, which are meshed properly at 80 F. Determine the change in center distance, ΔC, for the temperature range between −55 and +85 C.

The change in length per inch of length can be found from

$$\Delta l = \alpha(\Delta T) \qquad (3)$$

where α is obtained from Table 3. The change in length of Type 416 stainless steel, originally at 80 F and reduced to −55 C or −67 F, calculated from Equation 3 gives $\Delta l = 0.00082$ in. contraction. This causes the pitch radius of each gear to contract to 0.99918 in.

The change in length of aluminum Type 356-T6 when reduced to −67 F is 0.001749 in. contraction, which gives a contracted center distance of the mounting of 2.0000 − 2(0.001749) = 1.9965 in. This analysis shows that a situation exists where the sum of the pitch radii of the mating gears, 1.9984 in., is greater than the mounted center distance, 1.9965 in., and binding will occur at −55 C.

A similar analysis can be followed when the temperature is raised from 80 F to 85 C or 185 F. The changes in lengths are expansions, and the sum of the pitch radii becomes 2.0012 in., while the mounted center distance becomes 2.0025 in. This indicates that the gears will run freely, each gear taking a new operating pitch radius of 2.0025/2 = 1.0013 in.

The net result of this increase in center distance of 0.0013 in. causes an increase in backlash ΔB, calculated from Equation 2, of (0.0013) (0.72794) or 0.0009 in. At 80 F there was a backlash of 0.0004 in., so the total backlash at 185 F equals 0.0013 in., from which the lost motion can be calculated.

It can be seen that for successful operation of gears over an extended temperature range, compatible materials must be chosen.

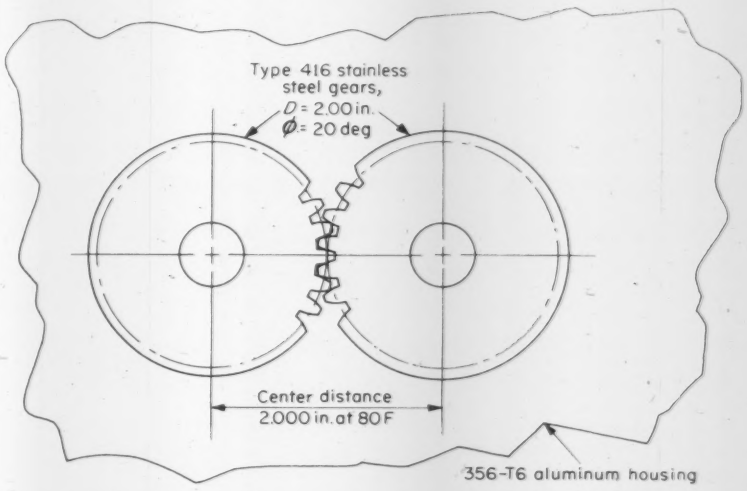


Fig. 7.1 — Center-distance change due to temperature change. Stainless-steel gears journaled in an aluminum-alloy housing. Gears cut with 0.0004 in. max backlash

Ball bearings have an advantage over sleeve bearings in this respect, in that a part of the radial play can be "taken up" by applying an end thrust on the inner race relative to the outer race. This is usually costly, and also difficult to control in assembly. It is common practice, therefore, to tolerate small amounts of radial play in the bearings of precision gear trains.

Shaft movement in a radial direction can also take place if either the OD or the ID of the bearing allows clearance to exist between the housing or shaft.

Since all the above kinds of radial play are additive, they will act as a single movement in a direc-

EXAMPLE 8

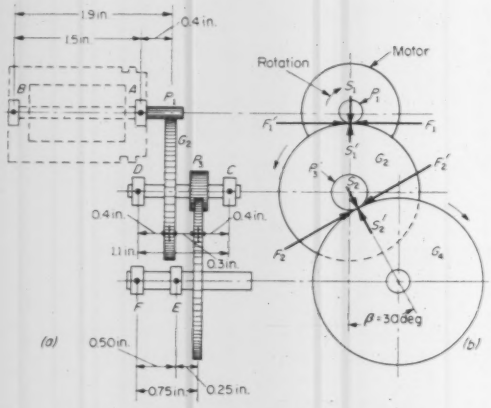


Fig. 8.1—Compound two-mesh train showing, *a*, bearing position, *b*, location and direction of forces

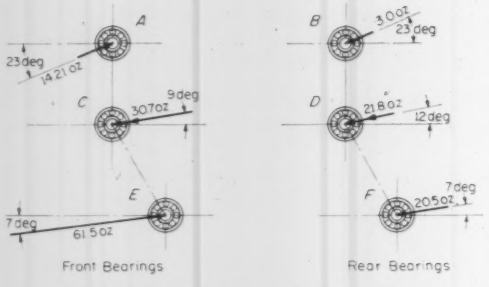


Fig. 8.2—Magnitude and direction of resultant loads on bearings

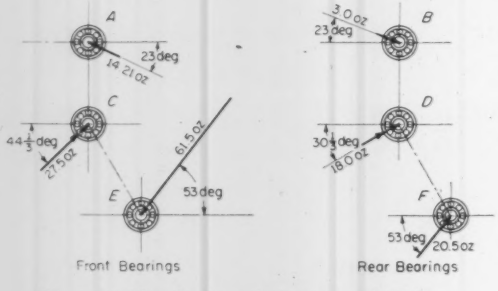


Fig. 8.3—Magnitude and direction of loads on bearings under reverse rotation

Fig. 8.1*a* shows a two-mesh gear system, for which the bearing loads must be determined. The values of the forces, Fig. 8.1*b*, can be determined from equations,

$$F = \frac{t}{r} \tag{4}$$

and

$$S = F \tan \phi \tag{5}$$

Equal and opposite reactive forces acting on the driving gears are denoted as F' and S'.

The data given for the train is:

Gear Number	Number Teeth	Pitch Diameter, D or d (in.)	Speed, (rpm)	Torque, t (oz-in.)
P_1	13	0.1354	6000	0.7
G_2	168	1.748	465	8.5
P_3	36	0.450	465	8.5
G_4	168	2.100	100	40.0

Each of the gears in the system has a 20-deg pressure angle but, because of mesh inefficiencies, this is increased to 23 deg.

Solution: The values of the forces for the first mesh, Fig. 8.1*b*, calculated from Equations 4 and 5, are $F_1 = 0.7/0.0677 = 10.34$ oz, and $S_1 = (10.34)(0.42447) = 4.38$ oz. From the data given, P_3 transmits 8.5 oz-in. of torque to G_4, so the forces of mesh become, $F_2 = 8.5/0.225 = 37.8$ oz, and $S_2 = (37.8)(0.42447) = 16.05$ oz-in.

Now that all the gear tooth forces have been calculated, only the effects which these forces have on each of the bearings must be determined. This is accomplished by drawing horizontal and vertical views of each shaft on which a set of bearings is located, and resolving all forces into components located in horizontal and vertical planes. All dimensions are in inches

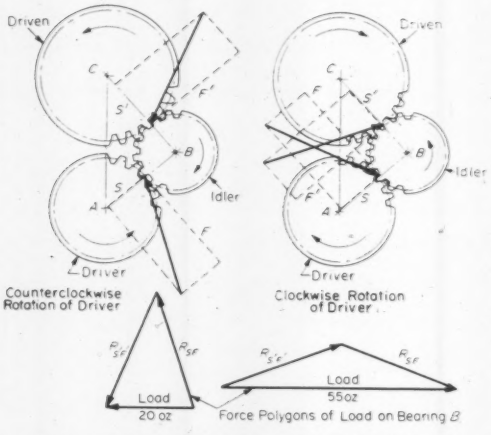


Fig. 8.4—Change in forces with change in direction of rotation in an idler system

tion depending upon the bearing load. In analysis work, it is helpful to investigate the amount and direction of the various bearing loads. This serves as a check on the bearing capacities, and at the same time reveals any probable trouble spots due to unfavorable radial play. If the radial play tends to separate two meshing-gear shafts under load, then an increase in backlash will be the result. The change in backlash may be computed by the same method used when tolerances on fixed centers were encountered.

Before the effect of radial play can be predicted, and all forces in ounces. An important fact to be remembered in bearing computations is that the bearings of driveshafts are loaded by the reaction forces of the driven gear, and the bearings on the driven-gear shaft are loaded by the forces induced by driving gear.

The following shaft analysis gives the position and magnitude of all bearing loads imposed by the gear train in transmitting a torque of 40 oz-in. to the output shaft.

Shaft AB

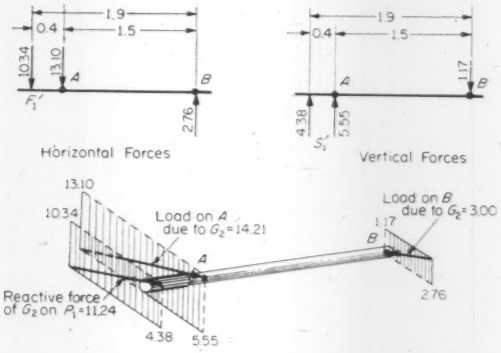
Horizontal load on bearing A due to $F'_1=(10.34)(1.9)/1.5=13.10$ oz.

Horizontal load on bearing B due to $F'_1=(10.34)(0.4)/1.5=2.76$ oz.

These two loads are opposite in direction and their algebraic sum equals 10.34 oz.

Vertical load components of S'_1 are calculated in a similar manner.

When these bearing forces are combined into resultants, the loads of which act at an angle of 23 deg with the horizontal, the loading diagram shown below is obtained.



Shaft CD

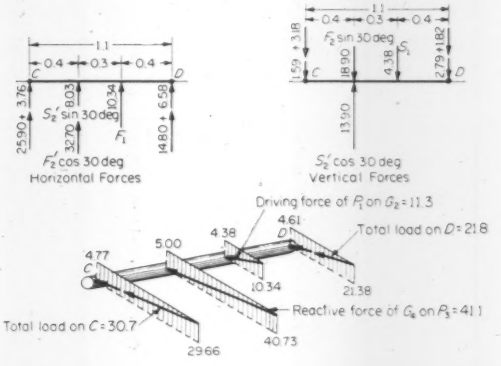
Horizontal load on bearing C due to $(S'_2 \sin \beta + F'_2 \cos \beta)=(40.73)(0.7)/1.1=25.9$ oz.

Horizontal load on bearing C due to $F_1=(10.34)(0.4)/1.1=3.76$ oz.

Horizontal load on bearing D due to $(S'_2 \sin \beta + F'_2 \cos \beta)=(40.73)(0.4)/1.1=14.80$ oz.

Horizontal load on bearing D due to $F_1=(10.34)(0.7)/1.1=6.58$ oz.

Vertical load components are calculated similarly and the resultants of all forces give a loading diagram as shown.



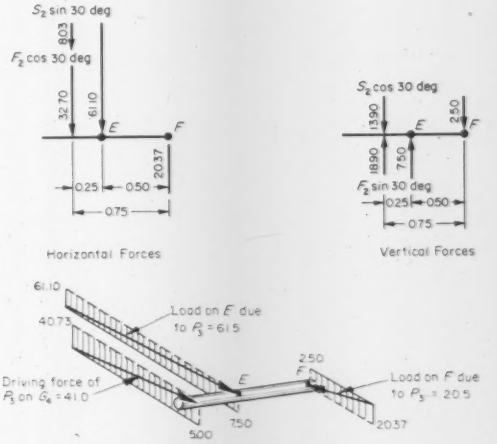
Shaft EF

Horizontal load on bearing E due to $(S_2 \sin \beta + F_2 \cos \beta)=(40.73)(0.75)/0.50=61.10$ oz.

Horizontal load on bearing F due to $(S_2 \sin \beta + F_2 \cos \beta)=(40.73)(0.25)/0.50=20.37$ oz.

Vertical loads are calculated in a similar manner.

These loads combine to give resultants which act at an angle of 7 deg with the horizontal or 23 deg with F_2, as shown.



The extent and direction of each bearing load, as determined from the preceding analysis, are shown in Fig. 8.2. This pictorial representation indicates that if radial play exists in bearings C and E, the magnitude and direction of the maximum loads could be a cause of lost motion between P_3 and G_4 due to shaft shift. Also, bearing E sustains twice the load of any other bearing, and if shaft shift problems are suspected, bearing E would be the likely cause.

To answer the question of what happens to the bearing loads when the direction of motor rotation is reversed, it is necessary to recalculate all loads using the reversed direction. Results of this determination for this example, Fig. 8.3, indicate that reversal of the motor rotation does not reverse the direction of the bearing loads.

Regardless of the direction of rotation of a driving gear, the separating force, S, is always in the same direction, that is, radially toward the center of the driven gear. However, the tangential force, F, reverses direction, which causes the new resultant to form a mirror image of the original rather than an equal and opposite force. The forces acting on the bearings of shaft CD do not follow this rule because they have their origin in pinion P_1 as well as gear G_4.

In some cases, reversal of the direction of rotation causes appreciable differences in bearing loads. For instance, a comparison of the loads induced on idler gear, B, Fig. 8.4, under different rotational directions, indicates an increase in loading by a multiplication factor of 2.75. In addition, the idler tends to move out of mesh, causing lost motion.

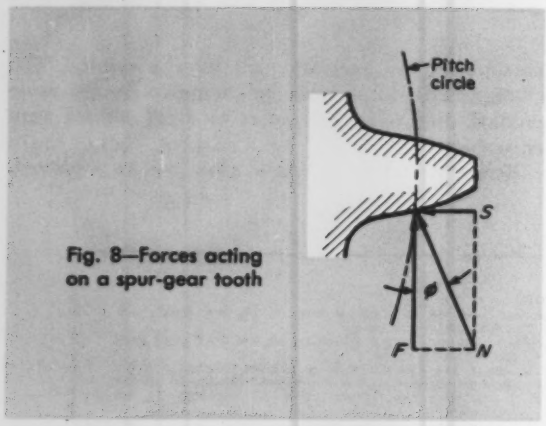


Fig. 8—Forces acting on a spur-gear tooth

its direction must be known, and the fundamentals of bearing load computation must be applied. In small gearbox mechanisms, the weights of the various members are usually neglected in bearing load computation, and only those loads due to the transmission of torque are considered.

The normal force, N, acting on a spur-gear tooth, Fig. 8, can be resolved into two components, a tangential or driving force, F, acting tangential to the pitch circle, and a separating force, S, acting in a radial direction. The gears are analyzed in pairs, Example 8, and the net results are summed. The effects on each of the bearings can then be determined.

An important consideration contained in the analysis of Example 8 is the effect that a change in rotational direction has on the bearing loads.

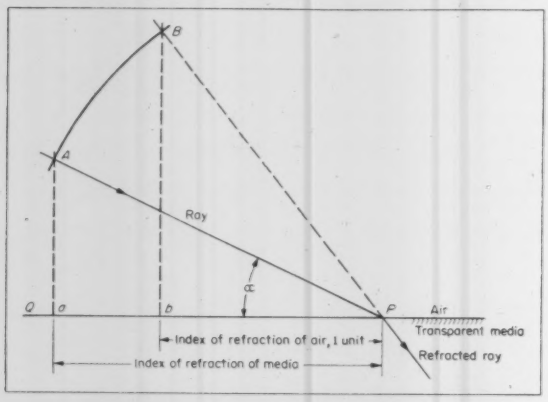
In the above example, the bearing loads on the intermediate shaft differ by only a few ounces in clockwise rotation when compared to counterclockwise rotation. In some instances, however, reversing the rotation of a gear train causes appreciable differences in bearing load.

Tips and Techniques

Angle of Refraction

A graphical solution can be used to simplify refraction problems, when angle of incidence, α, and the index of refraction of the material are given.

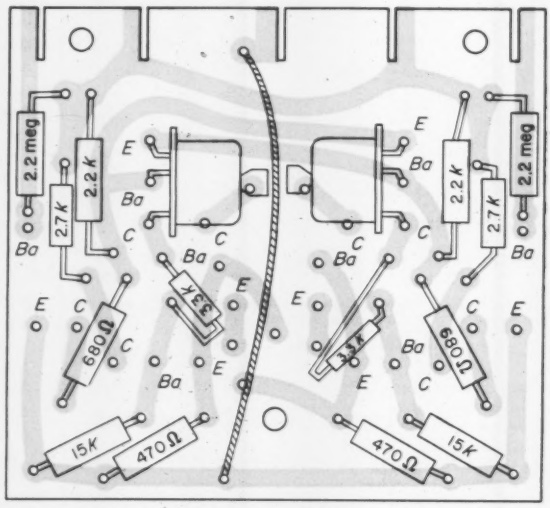
Draw PQ to represent the surface of the transparent media. Point b represents the index of refraction for air and is located one unit from P. Point a represents the index of refraction of the media and is located at a distance from P equal to the ratio of the refraction index of the media to the refraction index of air.



Next draw lines perpendicular to PQ at a and b. Lay out AP at the incidence angle α from PQ. With P as a center, and AP as a radius, draw arc AB. Draw line PB. The angle of refraction is the angle between PB and PQ.—M. L. THIEBAUX, *Whittier, Calif.*

Easy-To-See Circuits

To show complicated printed circuits clearly, superimpose the complex wiring, normally located on the back side of the printed circuit board, on the component drawing. Use of shaded or colored lines



on the back of the drawing makes the circuitry visible and does not obliterate the main drawing.—MYKOLA I. RUDENKO, *Flight Research Inc., Richmond, Va.*

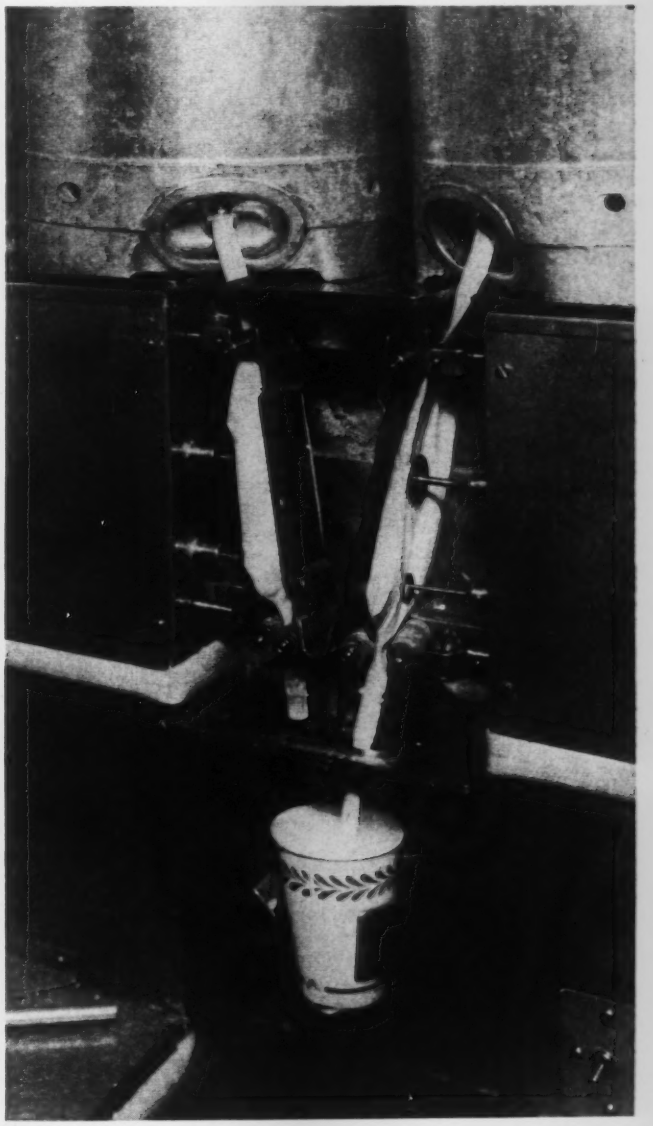
Do you have a helpful tip or technique for our other readers? You'll receive ten dollars or more for each published contribution. Send a short description plus drawings, tables, or photos to: Tips and Techniques Editor, MACHINE DESIGN, Penton Bldg., Cleveland 13, O.

Plastic Bag Doubles as Measuring "Cup" and Valve

DISPOSABLE PLASTIC BAG is the key element of a novel automatically operated flow-control mechanism. Applied in the new Cup-O-Matic milk-dispensing machine built by Food Engineering Corp., the bag is combination measuring unit and control valve made of Bakelite polyethylene plastic.

Sterilized electronically at the dairy plant, a bag is slipped on the bottom outlet of the can and folded to prevent contamination of inner surfaces of the plastic. When the milk can is installed in the vending machine, the bag is simply unfolded and slipped between top and bottom clamp mechanisms.

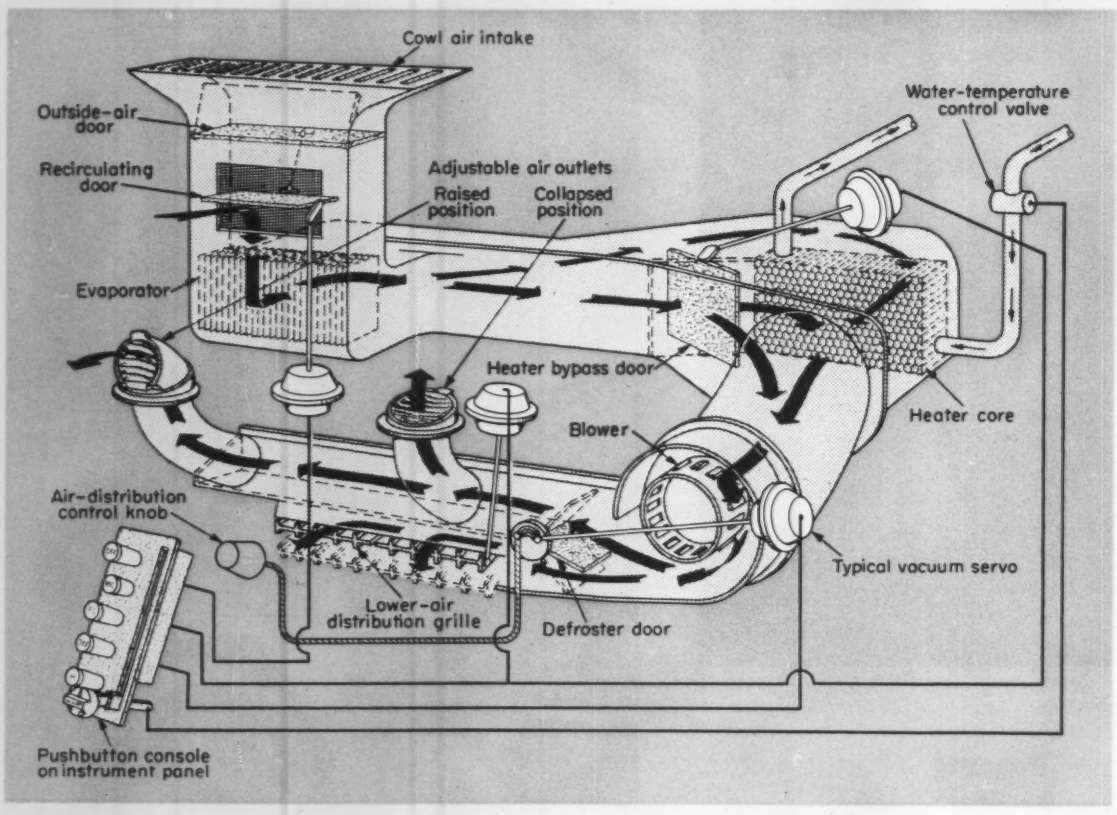
"ON-OFF" VALVE ACTION in the bag is accomplished by pair of double-roller clamps. When a coin is inserted in the machine, the bottom rollers clamp the bottom of the bag shut. The top rollers open, allowing the bag to fill, and then they close. The bottom rollers open, and the liquid drains into the customer's paper cup. Draining action is speeded up by two disc-shaped feet mounted on rods which knead the bag.



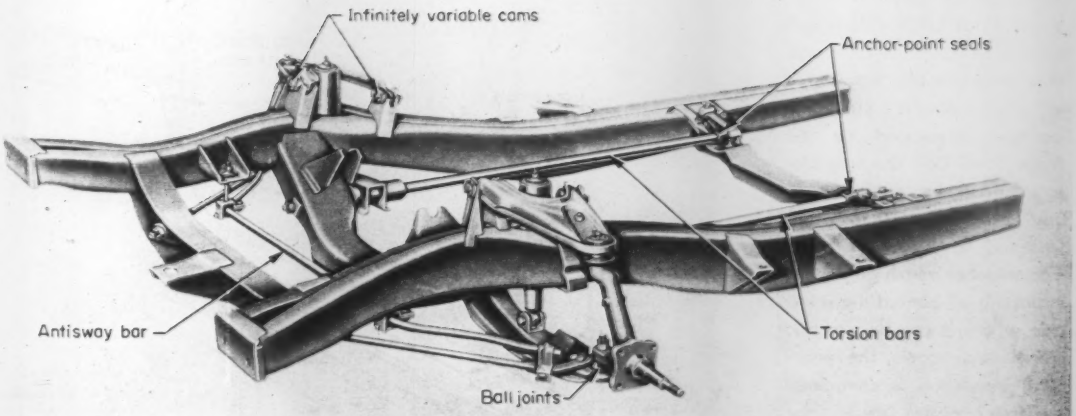
Pushbutton-Operated Damper Servos

ADJUSTABLE-POSITION AIR OUTLETS on top of instrument panel permit wide flexibility of circulation control in 1959 Chrysler Corp. cars. Elbow-shaped outlets on top can be telescoped out of the instrument panel and pointed in any direction. Air is distributed simultaneously to both sides of the car and along the floor by a divided air duct below the instrument panel.

DAMPER DOORS, which change air-flow paths through the air-conditioning and heating system, are controlled by push-button-operated vacuum servos. Labels on the buttons are OFF, MC (maximum cooling), FC (fully dehumidified, fresh-air control), DEF (defrost), and H (heat).

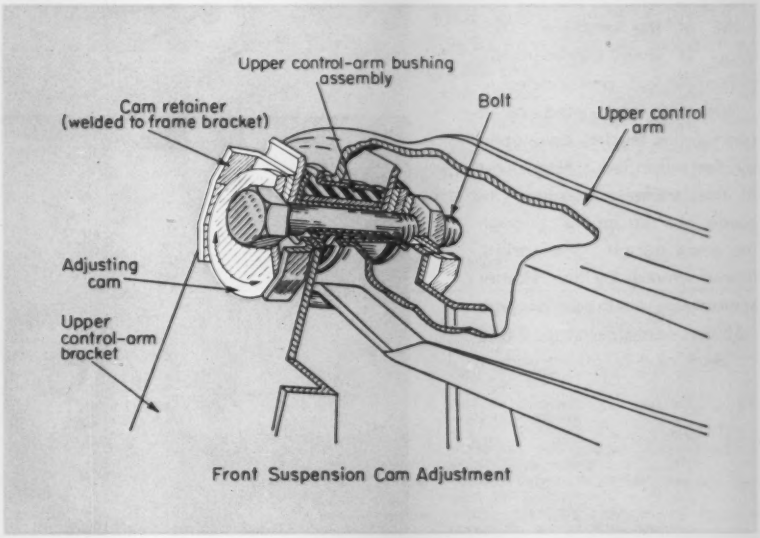


Control Car Cooling and Heating



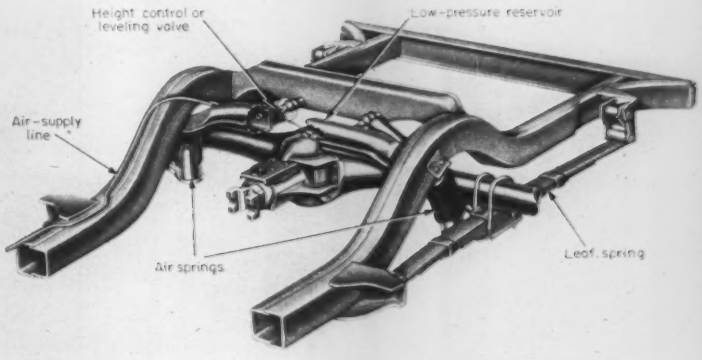
Front Suspension

PRECISE ADJUSTMENT of camber and caster on the front suspension is made with cam elements. The cams, which are infinitely variable, move the inboard ends of the control arms either toward or away from the center of the car. If the rear cam on a control arm is not changed and the front cam is rotated, the front of the control arm will pivot horizontally around its rear attaching point. Outward movement of the front of the arm will produce a greater caster angle to the rear.



Front Suspension Cam Adjustment

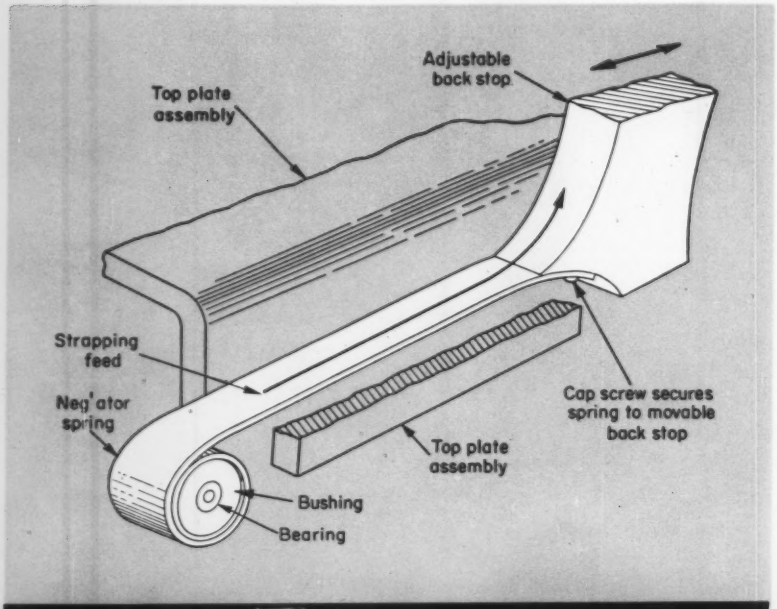
AUTOMATIC CAR LEVELING under varying load conditions is provided in the 1959 Chrysler Torsion-Aire suspension by a system which combines variable-rate air springs with leaf springs. Under extra-heavy loads, the height-control valve releases air into the air springs to maintain constant car height. When the excess load is removed, air pressure is automatically reduced.

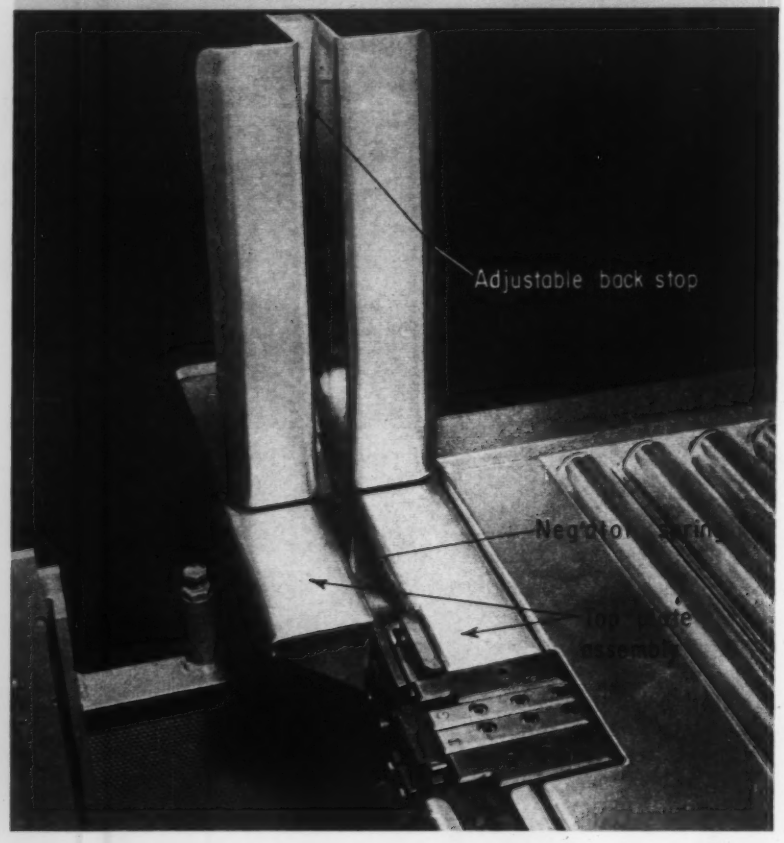


Flat Spring Forms Adjustable-Length Groove

SELF-COILING SPRING provides a flat adjustable-length surface to guide metal straps around packages. Applied in a semiautomatic strapping machine developed by the Acme Steel Co., the Neg'ator spring can be extended to any length up to 9 in. It is fastened to a curved backstop member which guides the strapping up behind the package where it can be grasped by the operator. The encircling operation is completed as the operator carries the strap over the package and inserts it into a slot in the table of the machine. The strap is then automatically tensioned, cut, and welded.

Although not used as a spring, the tension developed by the extended spring gives it the stiffness required to guide the strapping through the open trough. The spring, manufactured by the Hunter Spring Co., is made of type 301 stainless-steel strip, 0.010 in. thick and 0.750 in. wide





Filtering

HYDRAULIC CIRCUITS

Part 3

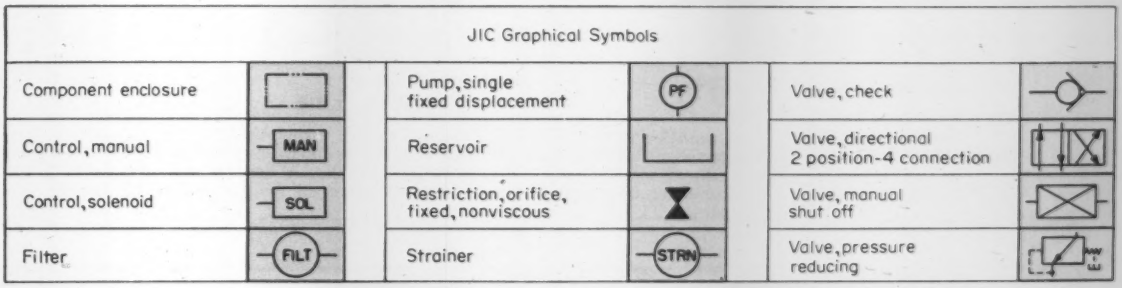
- *Performance*
- *Installations*
- *Circuits*

By JAROSLAV J. TABOREK
Research and Development Engineer
Phillips Petroleum Co.
Bartlesville, Okla.

SPECIFICATIONS for the filtration system of any hydraulic circuit depend ultimately on the nature of the operation the circuit serves. Such factors as the volume of fluid flow, and the size, structure, and composition of contaminants can be anticipated fairly accurately. They bear directly on the type and size of filters to be used. But other factors, less easily foreseen, may be decisive. The designer must ask: How much would a breakdown cost? An installation in aircraft is far more critical than one in a stationary machine. Other determining factors may be the degree of safety required and the dirt sensitivity of circuit components. Gear pumps, for example, are generally less sensitive than vane pumps under identical conditions. In the selection of filter elements and systems, comparisons like

Table 2—Types and Relative Performance of Filters

Type	Fineness (microns)	Efficiency	Working Pressure	Pressure Drop	Flow Volume	Absorption Capacity	Price	Characteristics and Applications
Surface								
Wire Screen	200 to 100	Low to medium	Low	Low	High	Low	Low	Used in pump suction lines.
Fine Grade	40 to 10	Low to medium	Low	Low to medium	Low	Low to medium	Low	By-pass installations. Serviced by cartridge replacement.
Edge								
Metal Discs and Ribbons	70 to 40	Medium	High	Medium to low	High	Low	High	Easily serviced without disassembly. Reusability unlimited.
Cellulose Ribbons	70 to 40	Low to medium	High	Medium to high	Medium to high	Low	Medium to low	Reusable elements. High working pressures for low price.
Cellulose Discs	10 to 1	High	High	High	Low	Low	Medium	Highest filtration fineness and efficiency Applicable on sensitive circuits.
Adsorbent	25 to 10	Medium to high	Low	High	Low	Medium to high	Medium to high	Separates oil oxidation products but also oil additives. Sensitive to water content.
Depth	40 to 10	Medium to high	Low to medium	Medium to high	Low to high	High	Medium to high	Filter elements adaptable to any shape and flow volume.



these should supplement the basic considerations: Performance of filter types, the effectiveness of filter installations, and the nature of filter circuits.

Performance

Primary data for filter selection is the size of contaminant particles to be screened. Theoretically, a filter should retain particles which have minor dimensions equal to or larger than the finest mean clearance on the working parts protected. Application of this principle is modified sometimes by the problems of installation, pressure drop, and cost.

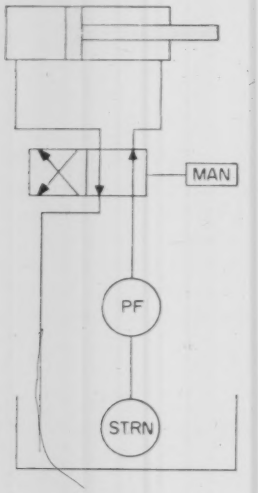
Filter Fineness: Most industrial circuits can use a filter fineness of 10 microns (0.0004 in.). If filtration this fine presents problems, the next most suitable grade is 25 microns (0.001 in.). In extreme cases, 40 microns grade (0.0016 in.) should give good service, especially if installed as a full-flow filter and supplemented by magnetic plugs which will separate iron particles smaller than 0.0016 in.

In a bypass installation, it should be kept in mind that filtration fineness does not guarantee corresponding overall quality of the filtration system. It is relatively easy and inexpensive to achieve nominal fineness of 1 micron in the filter itself, but the danger that particles of much larger sizes will shortcut the filter make a bypass installation only conditionally acceptable.

In a full-flow system, both filtration fineness and effectiveness are most commonly achieved by installing several filters in the circuit. While a bypass filter of the surface, depth, or adsorbent type permits a relatively inexpensive installation with a high degree of filtration, a full-flow filter of rather low fineness installed in the suction line gives positive filtration control. Effectiveness of the system is im-

Circuits

Applications of Filters in Typical Hydraulic Systems



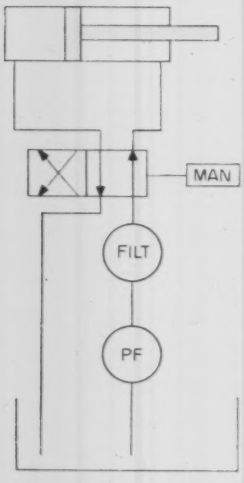
Suction Line

In most hydraulic circuits, the oil-intake line to the pump includes some type of strainer or filter. This location, at the very entrance to the circuit, makes filtration highly effective. Governing requirements for suction-line filters are low pressure drop and high-volume capacity.

Fineness of filtration is limited by the preferential requirement for extremely low pressure drop in the pump suction line. Permissible values of vacuum on pump suction are usually given by pump manufacturers and must be maintained.

Suitable wire-mesh strainers have nominal fineness between No. 70 sieve (200 microns or 0.008 in.) and No. 140 sieve (107 microns or 0.0042 in.). If finer filtration is required, other choices of filters are the paper-cartridge surface type and the cellulose-ribbon edge type. These types achieve filtration fineness between 70 and 40 microns. To obtain required rates of flow, several units can be arranged in parallel.

Suction filters in reservoirs should be so located that no parts of their filter surfaces are exposed. Otherwise, the housing-enclosed, in-line type filters should be used.

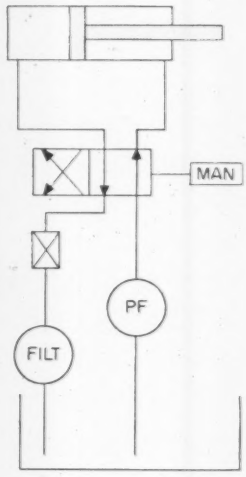


Discharge Line

The filter in this installation is located in the return line from the control valve to the reservoir. Main advantage is that all the oil is filtered at low pressure immediately upon its return from the work station. Danger of contaminants by-passing the filter is limited to an occasional relief valve discharge.

The main requirement of filters for this installation is high flow capacity. High pressure drop is tolerable.

Installation in a discharge line is most effective where full pump output flow is maintained through the return line most of the time. If a relief valve diverts flow too often, other filter locations should be selected.

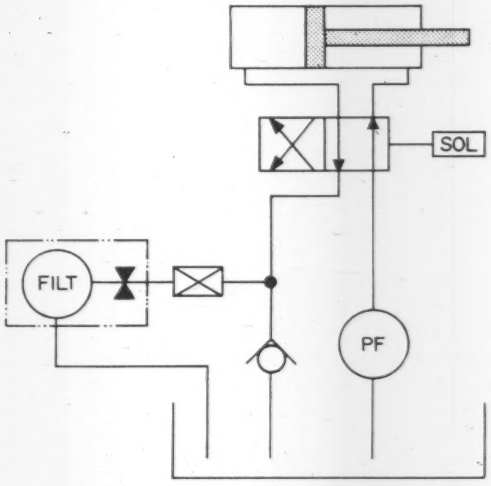


Pressure Line

Full-flow filtration is an advantage of this installation, but high pressure drop is characteristic of the filters required. Edge type filters of metal or cellulose ribbon are considered most suitable. A pressure-line installation can be used in place of a low-pressure, return-line arrangement in cases where the latter would create harmful back pressure.

Return-Line Bypass Circuit

A filter bypass off the main return line is economical and widely used on industrial circuits. The only functional limitation is that the back pressure created by the check valve must not interfere with operation of the circuit. Since any filter type is suitable in this installation, factors determining selection are fineness of filtration desired and price.

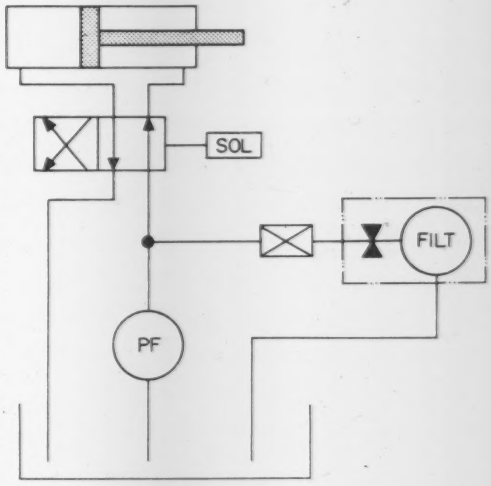


Pressure-Line Bleed-Off Circuit

Typical of bypass circuits, an orifice in the filter assembly maintains constant flow through the filter itself, subject to variations of circuit pressure. In case fluctuations in filter flow are not tolerable, a flow regulating valve can be installed in the filter intake line.

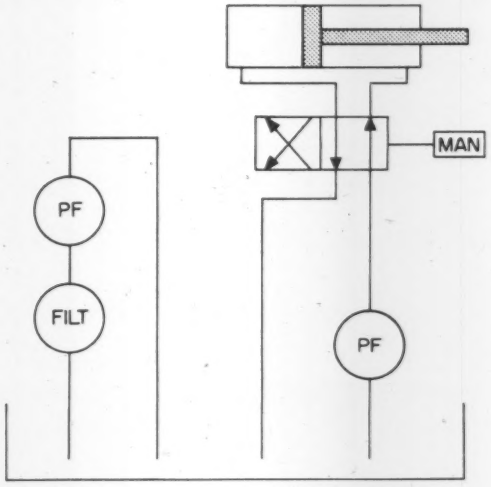
A further observation is that the flow through the filter is lost as effective pump output. This can usually be tolerated only on larger circuits.

There are no special requirements for the filter in this application. Working pressure is established by the flow regulator, and pressure drop through the filter is not important to the functioning of other components.



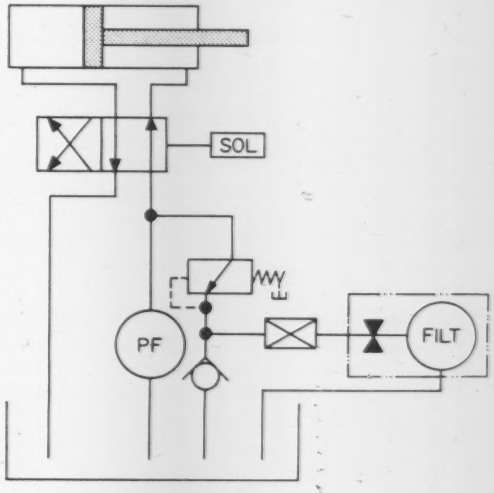
Independent Circuit

Fed from the reservoir, an independent circuit filters the full flow of its own pump. A disadvantage, common to bypass systems, is that certain quantities of contaminants evade the filter circuit. Capacities for elements of bypass circuits can be specified for independent systems.



Relief-Valve Bypass Discharge

A last resort, this system can be used if none other is suitable. Disadvantages are intermittent filter flow at best, and no filter flow when the relief circuit is idle.



proved by the addition of magnetic drain plugs.

Another way to achieve both fineness and efficiency is by cleaning the system after initial assembly with an externally connected full-flow filter, then leaving in the system only a bypass filter for normal operation.

Pressure Drop: There are several criteria for filter selection with respect to pressure drop:

1. The pressure drop must stay within limits determined by the structural strength of the filter element. This is usually given by the filter manufacturer.

2. For suction-line filter installations, pressure drop across the filter must not reach such values as to starve the oil supply to the pump. If this happens, the result is cavitation of the pump, detrimental to its life and performance. For the size of hydraulic systems most widely used in industrial applications—about 20 gpm—permissible suction vacuum is about 5 in. Hg or 2.5 psi. Since much of this is spent in supply lines, the maximum pressure drop permitted across the filter itself is about 0.5 psi or 1 in. Hg. This limit should be reached even with oil viscosity at its worst and with filters saturated to their capacity by contaminants.

3. Where filters are used in pressure lines, performance of installations is limited by their ability to dissipate heat created by the pressure drop across the filter. The rate of heat generation within a filter is

$$Q = 1.48\, q\, (\Delta p)$$

and temperature rise due to pressure drop Δp is

$$\Delta t = \frac{\Delta p}{340\, c_p\, S}$$

where Q = rate of heat generation, Btu per hr; Δt = temperature rise, F; q = fluid flow, gpm; Δp = pressure drop, psi; c_p = specific heat of the fluid, Btu per lb per deg F; S = specific gravity of the fluid. The usual acceptable maximum value of pressure drop is about 20 psi.

Maintenance: The desired frequency of maintenance and the degree of care which can be expected from service personnel influence filter selection. Proper maintenance can be expected only if accessibility and ease of servicing have been designed into an installation. Inspection and replacement of filter elements must be possible without draining the circuit and with minimum disassembly of other parts. If reservoir-mounted suction strainers are used, openings in the reservoir should be provided through which the strainer can be removed. The housing-enclosed, in-line type strainers and filters are best in this respect because the removal of only one bolt enables free access to the filter element.

For installations where maintenance must be infrequent or where proper care is unlikely, a type of filter must be selected which has high dirt-storage capacity. Dirt-storage capacity of surface-type filters is directly proportional to the filter area. For this reason, oversize filters are sometimes selected.

The fastest accumulation of contaminants occurs during initial run-in periods. Dirt from manufacturing and high initial rate of wear will be collected. The first cleaning or replacement of filter elements should be performed after about 500 hours. Further routine maintenance can be done at considerably longer intervals.

Easiest to maintain, metallic edge-type elements can be cleaned from the outside by actuating their scraper blades. The most difficult filter types to clean are probably the reservoir-located suction strainers.

▶ Installations

A typical hydraulic circuit consists of an oil reservoir, pump, control valve, an operating cylinder or other work-performing device, and an oil return line to the reservoir. Oil filters can be located at several places in a circuit, each location having its particular advantages.

Installations can be classified as three types, according to the locations of their filters:

Full-Flow Installations: An outstanding characteristic of this type is its effectiveness. In full-flow circuits, contaminant particles can not bypass the filter. However, this installation is generally more expensive than any other type. It requires large sizes of filters, fittings, and lines. In the case of pressure-line installations, the filter must also be able to withstand the maximum circuit pressures and pressure surges. Full-flow filters can be mounted in a suction line, in a discharge line from the control valve, in a discharge line from the relief valve, and in pressure

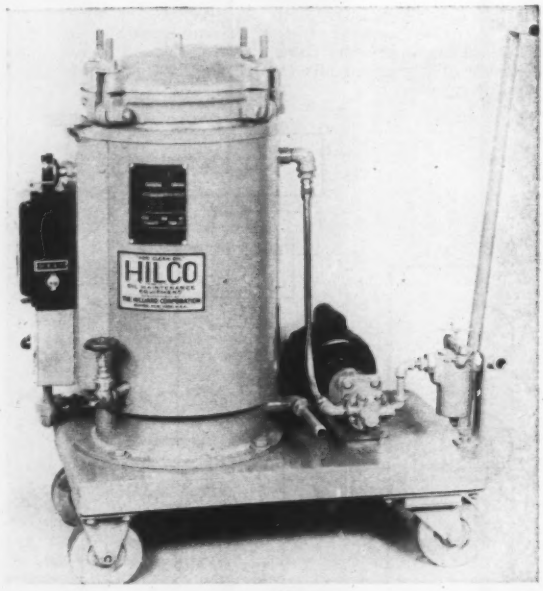


Fig. 20—Transportable, independent filtration unit, made by Hilliard Corp., Elmira, N. Y., purifies hydraulic circuits at scheduled periods on batch basis.

lines immediately following pumps.

Bypass Installations: This type will be generally more economical than other types. Only partial flow of the system goes through the filter. But this is a disadvantage, too, for there is no guarantee that particles will not eventually short-cut the filter and cause damage before they can be trapped. Consequently, bypass filtration can be considered adequate only as a sampling of the contaminants circulating in a system. The system should not be expected to give adequate protection against large particles.

For efficient functioning a certain minimum volume of oil must flow through a bypass circuit. This is determined from the JIC Standards H6.1.6, which recommends that all the fluid must pass the filter within 8 operating hours. Practically, the bypass system handles about 10 per cent of pump output. There are two main types of bypass-filter installations: Main return line bypass circuit, and pressure line bleed-off circuit.

Independent or Auxiliary Filtration Systems: Since they have no connection to filter systems built into equipment served, independent systems provide a variety of auxiliary filtration treatments. Scheduling, too, is flexible: One time only, or periodically at long or short intervals.

PERMANENT CIRCUITS: In large systems it is sometimes of advantage if a complete, independent filtration circuit can be installed. This system filters the full flow of its own small pump, fed from the main reservoir. Effectiveness, however, is about equal to that of a bypass system, because particles can, possibly, shortcut and filter. Specifications for auxiliary systems can be the same as those for bypass circuits.

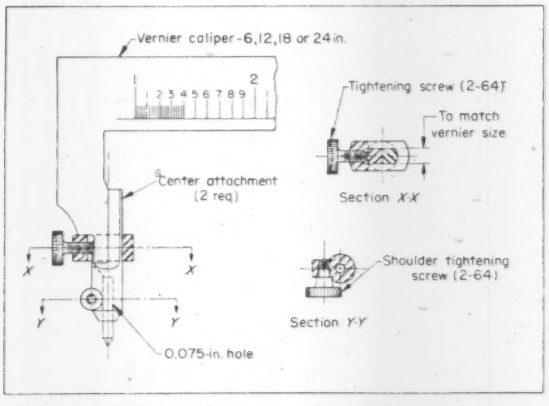
TEMPORARY FILTRATION: This system is based on the recognition that the largest amount and the most dangerous contaminants are those initially contained in the system or created during the break-in period. A large filter of nominal fineness around 25 microns is temporarily connected to the circuit, preferably to the pump suction line. The system is then operated for about 30 minutes, with all working devices operating under full load. This initial filtration permits the use of large-capacity bypass filters and provides a corresponding degree of effectiveness.

BATCH PURIFICATION: This designation covers all filtration and purification systems which treat the full volume of oil from hydraulic systems which have been in operation for long periods of time. Usually, batch purification supplements some kind of continuous filtration in large hydraulic systems. It is particularly effective if oil contamination consists substantially of water or water-soluble cutting oils. Batch-purification equipment usually consists of a self-contained transportable unit, Fig. 20, equipped with a large size filter for separation of mechanical contaminants. A reboiler with distillation unit is available if a complete redistillation of oil is required.

Tips and Techniques

Precision Compass

The need for a precision instrument often arises in tracing charts and precise drawings, and checking dimensions on small parts. Such an instrument can be fabricated from a vernier caliper of the required precision.



Two small, identical attachments, one containing a centering needle, the other a tracing point of hard grade lead, can be fastened to the legs of the caliper. Care should be taken to make sure the center line of the needle and lead points align with the measuring edges of the caliper.—ALBERT DROLET, *Charlesbourg, Quebec, Canada.*

Addition of Line Segments

Evaluation of data often makes it necessary to add a number of line segments. Measuring and tallying the segments, especially when they are of variable lengths, takes considerable time. A slide rule can be used to obtain accurate results very quickly.

When the ends of the slide rule are wrapped with tape, the hairline can be moved when the rule is laid flat on the desk. The center slide is removed. This makes the line segment visible through the opening. The hairline is aligned with zero, and the rule is placed so the hairline is at the end of the segment. The hairline is moved over the segment length. The rule is then moved to the next segment and the hairline moved again from its new position.

The total length is then measured with a scale, or closely approximated by noting the value appearing under the hairline on the common log scale.—G. T. KLEES, *design engineer, Detroit, Mich.*

Supplement 2

Design Guide to Industrial Fasteners

Detailed information on 213 fastener types in seven basic categories appeared in "Design Guide to Industrial Fasteners," August 23, 1956 issue, and the first supplement to the guide, June 27, 1957 issue.

This second supplement presents 40 additional fasteners announced since publication of the first supplement.

INSERTS

Jack Nut

Form: One-piece, all-metal, threaded, blind anchor nut. Consists of metal sleeve with threaded and flanged ends separated by a slotted expander section. Sleeve is pressed into drilled hole with flange against part surface. Screw is inserted to engage threaded end. As screw is tightened, the anchor backing is collapsed against part to form blind head, locking unit firmly in place.

Design Features: Provides a permanent, threaded anchor for blind or open application in any material. Can be used as rivet or blind fastener, and does not require special holes.

Materials: Cadmium-plated, aluminum-killed steel.

Sizes: Available in short length for thicknesses from 0 to 3/16 in. and long length for 0 to 3/8 in. Available for use with No. 6-32, 10-24 or 1/4-20 screws.

Source: Molly Corp., Reading, Pa.

Newton Self-Aligning Insert

Form: Two-piece insert assembly consisting of externally threaded outer sleeve and internally threaded inner sleeve. The inner sleeve is held in outer sleeve with a retaining ring. Insert is mounted in tapped hole, and grooves in external thread surface admit pins which are pressed into base of tapped hole to hold insert in place. Clearance of 0.040-in. between inner and outer sleeves permits internally threaded section to correct for bolt misalignment. Lugs on bottom of inner sleeve seat in notches in the outer sleeve to prevent the internally threaded section from pulling out when the bolt is tightened.

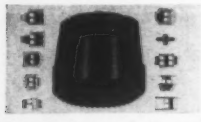
Design Features: Provides a strong, easily installed threaded hole in aluminum, magnesium, plastic and other material. Can be installed by hand in holes tapped with standard tools. Pin keys provide positive resistance to insert rotation when screw is tightened. Available with internal thread lock.

Materials: Carbon and stainless steel.

Sizes: 0-80 to 3/8-in. Fine internal thread sizes.

Source: Newton Insert Co., Los Angeles.

Perma-Lock



Form: One-piece, all-metal, threaded or plain-bore insert. Slotted collar holds the insert in place when pressed into bored hole. Upper section of insert has four segments bent inwardly which produce spring action on threaded member or shaft.

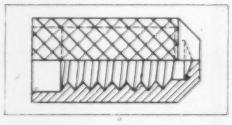
Design Features: Insert can be installed or removed with standard tools. Provides permanent thread or smooth-bore receptacle with built-in locking action.

Materials: Carbon spring steel.

Sizes: 0-80 to 1-in. nominal thread diameter or internal bore; Fine or Coarse threads.

Source: J. B. Plevyak Mfg. Co., Newton, N. J.

Yardley Type C Insert



Form: Internally threaded insert with knurled external surface. Component is designed to be molded in plastics, rubbers, and ceramics. Insert has countersunk hole and shoulder to accept threaded stud.

Design Features: Insert provides strong threaded holes in materials where

tapping is impractical or undesirable. Holes in insert are reamed after tapping to facilitate placing inserts on locating pins in dies.

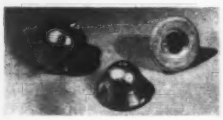
Materials: Aluminum.

Sizes: No. 4-40 to ¼-28 thread sizes.

Source: Yardley Precision Products Co., Yardley, Pa.

NUTS

GRC Tamperproof Cap Nut



Form: One-piece, all metal, threaded nut with wide washer base. Sides of nut are sharply tapered from base to top, and base has three notched recesses to accommodate a special wrench.

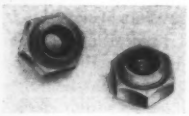
Design Features: Provides a smooth headed nut which conceals the end threads of axles. Head design requires a special wrench for installation, and prohibits cannibalizing of wheels. Wide base design provides integral washer and hole in top of nut provides lubrication hole.

Materials: Zinc alloy.

Sizes: Nut is ¾-in. high with No. ½-13 threads.

Source: Gries Reproducer Corp., New Rochelle, N. Y.

GRC Locknut



Form: Single-unit, prevailing-torque locknut consisting of dome-shaped, metal hex-nut body with molded nylon compression collar. Nylon element provides locking action by maintaining grip on threads.

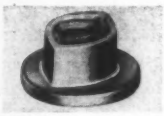
Design Features: Reusable. Provides secure vibration-resistant locking action and seals against moisture. Will lock at any point along mating screw where collar is engaged. Nylon collar is impervious to most chemicals and solvents.

Materials: Zinc alloy.

Sizes: Thread sizes from No. 4 to ½ in.

Source: Gries Reproducer Corp., New Rochelle, N. Y.

Kaylock Two-Point Locknut



Form: One-piece, all-metal, prevailing-torque locknut with two integral wrenching points and bearing flange. Upper threads of nut are elliptical and resilient. Walls of nut are forced into nearly circular shape, and pressure is exerted on bolt threads when bolt is assembled to nut.

Design Features: Reusable. Provides two integral wrenching points which permit wrenching on stem of threaded nut element. Elimination of hex wrenching surfaces provides a weight and space saving locknut. Installation is made with standard spin-type or socket wrenches. Bearing flange prevents wrench from touching work surface, which eliminates scoring, and eases engagement with mating hole.

Materials: Heat-treated carbon steel and corrosion-resistant steel.

Sizes: No. 4-40, 6-32, and 8-32.

Source: Kaynar Mfg. Co. Inc., Los Angeles.

KSM Weld Pad

Form: One-piece, all-metal, internally tapped, cylindrical pin with solid flux tip. Pad becomes permanent receptacle for threaded fasteners when welded to parent material by semiautomatic electric arc welding.

Design Features: Provides a permanent tapped hole that can be installed at high speed. Eliminates drilling and tapping.

Materials: Low-carbon steel, and stainless steel.

Sizes: ⅛ to 1⅛-in. weld base diameters. Maximum internal thread diameters from No. 8-32 through ⅝-11. Lengths from 3/16 to 36 in.

Source: KSM Products Inc., Merchantville, N. J.

M-F Weld Nut

Form: All-metal hex nut with three projections on bottom face. Available with pilot shoulder or recess around hole. Both nuts are projection welded and are available with or without M-F "Two-Way" locking feature, which provides locking action in the middle of the nut.

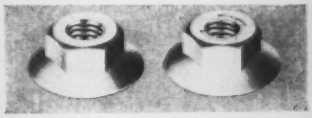
Design Features: Provides a low cost, rapidly assembled nut or tapped hole. Pilot design facilitates positioning of nut in assembly. Weld flow or spatter are prevented with either pilot or recessed types.

Materials: Cold-forged steel.

Sizes: No. 8 to ½ in.; Coarse and Fine threads. Class 2B. Pilot type has two pilot sizes, long for material 13 gage or thicker, and short for 14 gage or thinner.

Source: MacLean-Fogg Lock Nut Co., Chicago.

M-F Flange Nut



Form: One-piece, all-metal, free-spinning locknut consisting of hex nut with integral flange. Flange face provides positive locking action when nut is seated.

Design Features: Provides a strong, economical locknut. Eliminates separate washers. Available with or without Uni-Torque locking feature.

Materials: Cold-forged steel.

Sizes: ¼ to ½-in. Unified Coarse and Fine threads; Class 2B.

Source: MacLean-Fogg Lock Nut Co., Chicago.

Palnut Self-Threading Locknut

Form: One-piece, all-metal locknut consisting of hex head with thread-forming upper section and washer base. Threads are formed as nut is drawn-up on stud, rod, or rivet. Locking action is provided by spring action of resilient washer.

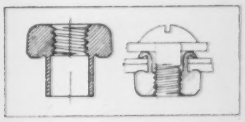
Design Features: Removable and reusable on same stud. Eliminates separate threading operation, and provides 360-deg contact on flat or irregular work surfaces. Hex form fits all standard tools and shanks.

Materials: Spring-tempered steel. Available with bonded-in plastisol sealer.

Sizes: For ⅛, 3/16, and ¼-in. stud sizes.

Source: Palnut Co., Mountainside, N. J.

Perma-Nut



Form: One-piece, all-metal, tubular rivet with internal threads in a drilled-through head. Sixteen serrations on underside of head bite into surface and prevent turning. Unthreaded, tubular

section is set against work with roll clinch.

Design Features: Combines permanence of a rivet with disassembling advantage of a nut. Can be employed to permanently join two or more elements of a subassembly while providing an attachment nut. Serrations provide resistance to turning, or torque capacity, greater than strength of internal thread.

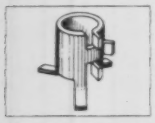
Materials: Steel, brass, and aluminum. Brass is not recommended with fine series threads.

Sizes: No. 3-48 through 1/4-120 thread sizes. Lengths from 1/8 to 3/8 in.

Source: Tubular Nut and Stud Co., Quincy, Mass.

RETAINING RINGS

Compression Ring Speed Clip



Form: One-piece, all-metal, tubular-type compression ring with three tabs at side of ring. Three resilient legs are provided at end of ring.

Design Features: Provides grip on studs for flexible mounts. Squeezing the three compression tabs together enables the ring to be slipped over the stud. When the tabs are released, the ring contracts, and three small barbs on inside of ring provide flexible and firm retention.

Materials: Heat-treated spring steel.

Sizes: For shaft diameters from 5/32 to 9/32 in.

Source: Tinnerman Products Inc., Cleveland.

Rotor Clip

Form: Stamped metal retaining rings. Rings are mounted in annular groove in shaft or housing bore. Size is engraved on each ring.

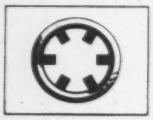
Design Features: Provides low-cost means of locking and positioning parts on shafts and in housing bores. Tapered design affords lower stress at the mid-section. Adaptable to high-production assembly techniques. Engraving provides foolproof size identification.

Materials: Carbon spring steel, stainless steel, bronze, and beryllium copper.

Sizes: 0.040 to 2.50 in. nominal shaft diameters, 0.250 to 3.75 in. nominal bore diameters.

Source: Rotor Clip Co., Farmingdale, N. Y.

Truarc Self-Locking Ring



Form: Stamped-metal, external, self-locking retaining ring with reinforced arched rim and internal locking prongs. Installed on ungrooved shaft, rings grip surface under spring action of tabs to lock ring in place.

Design Features: Accommodates shaft tolerances from ±0.003 to ± 0.005 in. Reinforced arched rim provides strength and resistance to bending, twisting, and buckling. Ring provides increased thrust-load capacity. Particularly effective on irregularly shaped parts.

Materials: Carbon spring steel and stainless steel.

Sizes: 3/32 to 1-in. nominal shaft diameters. Thicknesses for smaller sizes, 0.010, 0.012, and 0.015 in.; and for larger sizes, 0.015 and 0.02 in.

Source: Waldes Kohinoor Inc., Long Island City, N. Y.

RIVETS

Caplet

Form: One-piece, solid, metal rivet in which the standard Coopers' belt rivet head has been covered with plastic insulation.

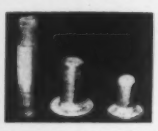
Design Features: Insulated head provides electrical insulation for over 5000 v. Driven rivet provides secure joint. Applications include use in electrical and electronic equipment requiring insulation of fastener from components, as actuator knobs used on relays and switches, and for "feet" on desk equipment, and appliances.

Materials: Aluminum, brass, and steel shanks.

Sizes: 1/16, 3/32, and 1/8-in. shank diameters; shank length in multiples of 1/32 in.

Source: Pylon Co. Inc., Attleboro, Mass.

Pastushin Fluid-tight Slug Rivet



Form: One-piece headless rivet with aluminum-alloy sleeve on shank. Rivet is driven through material to be fastened. Alloy sleeve extrudes into leak areas between rivet and bore as rivet is driven. Countersunk hole in one fastened part provides space for upset of rivet to maintain flush head. Head and maximum flow of rivet shank material is obtained around flush head and upset end during driving.

Design Features: Provides positive sealing between rivet and bore without the addition of foreign sealing agents. Headless type rivets are for use with automatic machines. Two other available types, the washer rivet and the replacement rivet, have preformed heads and are driven with conventional hand tools.

Materials: Shank is 2117-T4 aluminum alloy, sleeve is 1100 aluminum alloy.

Sizes: 5/32, 3/16, and 1/4-in. diameter.

Source: Pastushin Industries Inc., Los Angeles.

Pin-Grip

Form: Two-piece, tubular, blind rivet consisting of preassembled slotted sleeve and knurled drive pin. When pin is driven flush with head, slotted sleeve expands on blind side to form blind head. Simultaneously, the knurled pin locks itself in position.

Design Features: Rivet is easily driven from one side with hammer. Knurled pin provides positive lock of sleeve and resists vibration. Suitable for blind or limited-access applications.

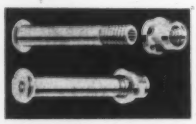
Materials: Sleeve is aluminum, pin is stainless steel.

Sizes: 1/8 to 1/4-in. nominal diameter. Various grip lengths. Head styles include universal, countersunk, full brazier, round and flat splash, and panel.

Source: Star Expansion Industries Corp., Mountainville, N. Y.

SCREWS, BOLTS, STUDS

Fastbolt



Form: Two-piece, all-metal bolt assembly consisting of a bolt with diaphragm head and recessed socket in thread end, and a nut which combines

free-spinning and prevailing-torque principles. Nut is internally threaded, integral washer unit with hex wrenching surfaces. Washer surface has 1 deg internal angle which provides positive tension lock when tightened down. The threads in tail section of nut are swaged uniformly to a reduced size which provides secondary locking action against threaded section.

Design Features: The recessed socket enables the bolt to be held from the driving side for semiblind application. The internal angle in washer surface distributes torque load evenly and provides positive locking action.

Materials: Aluminum, alloy steel and titanium.

Sizes: 3/16 to ½-in. nominal diameter. Head styles include protruding diaphragm and countersunk flush head.

Source: Vio-Shan Mfg. Co., Culver City, Calif.

GRC Self-Insulating Fasteners

Form: Metal shanks with plastic heads molded on metal insert. Are applied to screws, bolts or rivets.

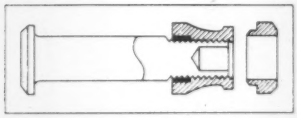
Design Features: Plastic heads prevent corrosion and moisture absorption by sealing at critical points. They withstand impact, have good thermal insulating properties, and prevent galling of contact surfaces.

Materials: Heads plastic, shanks ferrous and nonferrous metals.

Sizes: Standard screws, bolts and rivets.

Source: Gries Reproducer Corp., New Rochelle, N. Y.

Hi-Lok



Form: Two-piece, all-metal, bolt-type fastener, consisting of an externally threaded pin and an internally threaded collar. The threaded pin end has a hex socket recess for holding. One end of the collar is internally recessed to provide for variation in material thickness. The other end of collar has torque-off wrenching device which controls residual tension or preload. As the collar is snugged up, the pin is held by a hex wrench in the recess. When the torque of the collar reaches the pre-established torque level, the hex head torques off, leaving essentially a rivet construction.

Design Features: Pin reusable. Provides consistently controlled preload and allows for snugging up prior to final torque-off. Can be adapted to high-speed assembly methods. Has features of both bolt and rivet. Installation is possible from one side of work.

Materials: Titanium, alloy steel, stainless steel, and aluminum.

Sizes: 3/16 to ⅜-in. pin diameters. Head styles include protruding and countersunk flush.

Source: Hi-Shear Rivet Tool Co., Torrance, Calif.

Hi-Shear Alignment Bolt

Form: One-piece bolt-type construction with a necked-down shank. Threaded one end, with a flat head and hex socket recess on other. Upper shank has hole drilled to necked down area which is filled with nylon or thermosetting plastic.

Design Features: Reusable. Provides a lightweight high-torque bolt for aligning misaligned parts. Bolt is driven with hex-type internal wrenching device. Filler prevents trapping moisture.

Materials: Alloy or stainless steel and titanium.

Sizes: Shank diameters to ⅝ in. Thread diameters one bolt size smaller than sank diameter. Length to 3 in.

Source: Hi-Shear Rivet Tool Co., Torrance, Calif.

KSM Weld Stud

Form: Standard threaded stud with a solid flux tip. Stud is welded to parent material by a semiautomatic electric arc welding process.

Design Features: Eliminates need for tapped holes. Provides a permanent stud attachment that can be installed at high speed. Flux tip can be used as center punch location point.

Materials: Low-carbon mild steel, and stainless steel.

Sizes: ⅛ to- 1⅛-in. weld base diameters. Lengths from 3/16 to 36 in. Standard NC threads. Available fully or partially threaded.

Source: KSM Products Inc., Merchantville, N. J.

McCormick-Selph Explosive Bolt

Form: Standard all-metal bolt with integral or separate explosive charge. Bolt has hex head, and has an annular separation groove cut around the shank. A hole is bored through head and shank to grooved section. Explosive section is inserted in hole. When initiated, the charge produces a high-order detonation and creates a shock wave in the metal of the bolt assembly. The wave progresses longitudinally through the bolt until it reaches the section containing the bottom of the bored hole. At this point, a stress concentration occurs which exceeds the ultimate strength of the bolt section and a clean fracture and positive separation occurs.

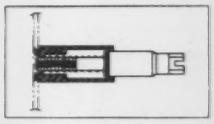
Design Features: Fastener performs bolt-holding function and can still be broken at a predetermined point by an electrically actuated charge. Unit is not sensitive to pressure or temperature. Safety is increased since an explosive cartridge may be installed after bolt is installed in structure. Produces accurate separation with a minimum of fragmentation.

Materials: High-tensile steels.

Sizes: All standard bolt sizes and shapes.

Source: McCormick Selph Associates, Hollister, Calif.

Moran Captive Bolt



Form: Three-piece bolt assembly consisting of swaged-in-place sleeve, spring, and bolt. Bolt has threaded shoulder and shaft. Two threads in top of sleeve accommodate the threaded bolt shoulder. Two turns of bolt carry it through threads to become captive within sleeve, held in place by small tension spring.

Design Features: Subassembly is fastened tightly to major assembly by turning bolt into mating fastener until bolt tightens on shoulder in sleeve. Eliminates loose parts. Hexagonal, slotted head permits installation with screwdriver or wrench.

Materials: Sleeve is aluminum alloy, spring is spring-steel wire, and bolt is steel alloy.

Sizes: No. 8-32 NC threaded bolt with length from 1.6 to 4.0 in.

Source: Moran Co., El Segundo, Calif. with length from 1.60 to 4.00 in.

Multitork

Form: High strength, flush-head bolt with recess of two uniformly radiused slots separated by a portion of the bolt head. Bolt is tightened with a special socket type driver.

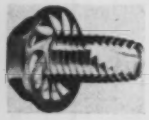
Design Features: Provides high torsion strength, fatigue life, and reduces breakage during installation.

Materials: Tool steel, Vasco-jet, and superalloys.

Sizes: ¼ through ⅝-in. shank diameters.

Source: Briles Mfg. Co., El Segundo, Calif.

Nibscrew



Form: One-piece, all-metal, thread-cutting screw with nibs under head. Head takes up torque when nibs become seated.

Design Features: Provides resistance to stripping in applications which have little screw-thread engagement. Permits a broad range of driver settings.

Materials: Steel, aluminum, stainless steel.

Sizes: No. 6 through ¼-in. screws of various lengths. Hexagon washer, truss, and pan heads available.

Source: Shakeproof Div., Illinois Tool Works, Elgin, Ill.

No-Mar Set Screw

Form: Fully threaded screw with special nylon insert in tip for engagement with mating surface. Slotted head provides flush surface fit.

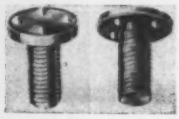
Design Features: Permits positive locking action. Nylon insert takes shape of holding member and prevents marks or burrs.

Materials: Stainless steel with nylon insert.

Sizes: No. 2-56, 4-40, and 6-32.

Source: PIC Design Corp., Subsidiary of Benrus Watch Co. Inc., East Rockaway, N. Y.

Rimguard Weld Screw



Form: Flat-top, round-headed screw with four weld projections and protective rim on top or bottom side. Screw is projection welded in place on part surface. Rim limits, to a predetermined degree, the pressure applied to projection during fusing.

Design Features: Provides a permanent fixed screw attachment for metal parts. Provides proper diffusion of weld metals, and minimizes spatter and flash.

Material: Low-carbon steel.

Sizes: No. 6-32 to ⅜-16 nominal diameters; Class 2A threads, ¼ to 2-in. lengths.

Source: Parker-Kalon Div., General American Transportation Corp., Clifton, N. J.

Shakeproof Mounting Screw

Form: One-piece, all-metal mounting screw incorporates two types of threads, crescent-shaped "nibs" under the head, and an alignment point. When screw is driven into panel, the left hand upper threads and nibs retain it. Standard right-hand machine-screw threads form a stud. Tightening the nut down on the stud also tightens mounting screw, and nibs prevent stripping when nut is torqued.

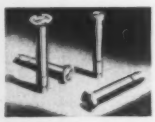
Design Features: Provides stud mounting in blind or open application. Eliminates retaining device, and point eliminates cross-threading. Screw has applications in wood, masonite, composition board, and other materials.

Material: Steel.

Sizes: No. 6, 8, and 10 screws of various lengths.

Source: Shakeproof Div., Illinois Tool Works, Elgin, Ill.

Sleev-Lock



Form: All-metal, preassembled unit for blind application, consisting of outer sleeve, nut, and inner-core bolt. Special attachment holds outer sleeve stationary while driving core bolt. This draws expandable nut up over end to knurled sleeve to clamp assembly together. To remove, drive is reversed to withdraw core bolt. Nut is pushed off end of sleeve which is then withdrawn.

Design Features: Sleeve and bolt are removable and reusable. Eliminates drilling to remove. Prevailing-torque type nut provides double-locking action when pulled over knurled sleeve. High strength and vibration resistant. Preload can be controlled in driving tool.

Materials: Titanium, and stainless and high-strength steels.

Sizes: 3/16 to ⅜-in. diameter. Various grip lengths. Available in countersunk flush and protruding hex steels.

Source: Standard Pressed Steel Co., Jenkintown, Pa.

Sleev-Scru

Form: One-piece, metal screw with an integral cladding of Mylar polyester film on the shank. Diameter of insulated shank is same as OD of threaded section.

Design Features: Provides electrical insulation between fastener and assembled parts. Eliminates insulating tube assemblies. Permits reduction in size and weight of overall assembly.

Materials: Steel, brass, and stainless steel. Mylar insulation.

Sizes: No. 2-56 to ¼-20. Lengths from ¼ to 3 in.

Source: Pylon Co. Inc., Attleboro, Mass.

Spin-Seal

Form: Preassembled screw and sealant washer. Washer is dome shaped with a plastic sealant applied to the underside. Washer is held securely in position under screw head by the sealant which has a hole smaller than the OD of the screw thread.

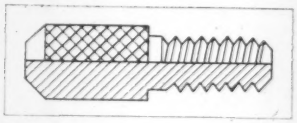
Design Features: Provides secure seal on irregular, curved, and flat surfaces. Washer does not turn when screw is tightened, minimizing surface score.

Materials: Carbon or stainless steel.

Sizes: No. 6 to ½ in. Screw styles and washer sizes include a number of different standard combinations.

Source: Russell, Burdsall and Ward Bolt and Nut Co., Port Chester, N. Y.

Yardley Type D Stud



Form: Threaded stud with knurled external surface. Designed to be molded in plastic, rubber, and ceramics.

Design Features: Provides a permanent threaded stud attachment for molding into suitable nonmetallic materials.

Material: Aluminum.

Sizes: No. 4-40 to ¼-28 thread sizes.

Source: Yardley Precision Products Co., Yardley, Pa.

WASHERS

Bartite Sealing Washer

Form: One-piece washer unit consisting of dome-shaped metal retainer into which sealing compound is bonded. Tightening the fastener forces the sealant into cavities between clearance hole and fastener thread, fastened material and washer, and fastener head and washer hole.

Design Features: Sealing compound is stable, nonaging and withstands temperatures from −100 to +250 F without change. Provides effective seal against water, oils, greases, acids, alkalies, salts, alcohols, hydrocarbons, and ozone.

Materials: Retainer is mild, high-carbon, heat-treated, or stainless steel. Sealing compound is of polyvinyl chloride base.

Sizes: Standard screw and bolt up to ½-in. diameter.

Source: L. J. Barwood Mfg. Co. Inc., Everett, Mass.

Compression (Belleville) Washer

Form: One-piece, all-metal, conical-disc washer. Locking action is obtained through the washer compression as the nut or bolt is tightened.

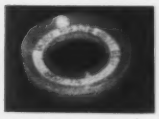
Design Features: Reusable. Designed to be used under static loads. Washers maintain a higher bolt or stud load than conventional washers.

Materials: All standard engineering materials.

Sizes: ¼ to 1⅛-in. bolt sizes. Sizes vary with manufacturer.

Source: Produced by several manufacturers. Photo courtesy Solon Mfg. Co., Solon, Ohio.

Dubo-Ring



Form: One-piece nylon lockwasher with a double V shape. Locking action is obtained when nut is tightened against washer. When the nut is tightened, the ID of the washer grips into the threads of the bolt and nut, and flows into the opening of the tapped hole. Simultaneously, the OD flows over the outer edges of the nut, locking and sealing it.

Design Features: Reusable. Provides self-sealing and self-locking action. Will not gall or seize mating threads. Vibration and shock do not affect the positive double-locking action. The washer is stable to 420 F. Tensile strength is 10,000 psi.

Materials: Nylon 6.

Sizes: ⅛ to 1½-in. nominal ID.

Source: Nylogrip Products, Newton, Mass.

Sawtooth Lock Washer

Form: One-piece, all-metal, spring-type washer with tooth projections on head and mating sides. As bolt is tightened, static lock is provided by spring action and dynamic lock by grip of teeth.

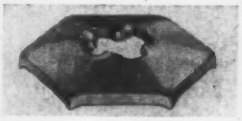
Design Features: Sawtooth action provides nonslip, antivibration locking action.

Materials: High and low-carbon steels, stainless steel, bronze, and aluminum.

Sizes: Available in all standard sizes.

Source: George K. Garrett Co. Inc., Philadelphia, Pa.

Shakeproof Lock Washer



Form: One-piece, all-metal lock washer with ribbed under-structure and tooth-like projections around clearance hole. Periphery of washer has sharp edges and points. Locking action is induced as nut is tightened against washer.

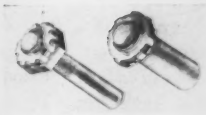
Design Features: Ribbed structure affords rigidity and resilience under heavy loads. Sharp edges of washer prevent slippage and internal teeth lock the washer to bolt head or nut. Can be preassembled onto screws.

Material: Carbon steel.

Sizes: ¼ to 9/16-in. screw diameters.

Source: Shakeproof Div., Illinois Tool Works, Elgin, Ill.

Sta-Lok



Form: Two-piece, all-metal lockwasher assembly consists of a lugged ring nut or hex nut with a recessed groove and an internally serrated washer with tang projections. For use in bearing assemblies, the nut is torqued to the proper valve, the lockwasher is aligned on the end of the shaft so that a pair of tangs fit around the lug on the nut. Washer is then driven over the shaft. The serrations cut or engage until the retaining tangs lock in place over the nut. For installation on all but large-size bolts, the serrations are formed on the bolt as the washer is pressed over the threads. With hex-head nut, the tangs extend down and over sides of nut. Several of the tangs have a 90 deg bend to snap-in and lock in the recessed groove on the nut.

Design Features: Serrations secure rotation of washer with respect to bolt while tangs prevent nut from rotating and also prevent axial movement of washer. Fatigue strength of nut bolt connection is not affected since lock is applied at top of nut. Nut may be torqued to desired preload; backing off is not required to make washer fit since large number of serrations permits engagement in almost any position. Serrations on top end of bolt thread do not affect the thread. Washers are primarily for use in vibration assemblies. Washers are available separately under name "Shur-Lok."

Materials: Carbon or high-temperature alloy steels.

Sizes: For hex nuts from No. 10 to 2-in. diameter; for bearing locknut in all common sizes of NAS and SAE series.

Source: Shur-Lok Corp., Anaheim, Calif.

The Personal Side of Engineering

By **EDWIN C. NEVIS** Personnel Research and Development Corp., Cleveland, Ohio

Does Brainstorming Work?

RECENTLY, much attention has been focused upon the technique of brainstorming. While brainstorming-type approaches to problem-solving are quite old, the present interest stems from the impact created by Alex Osborn in his book, *Applied Imagination*.[1] Used by Osborn originally as a means of developing ideas for advertising and promotional work, the technique has now been used in a variety of situations, with great claims being made for its effectiveness.

Simply stated, brainstorming is a kind of free-for-all idea session in which the participants are encouraged to give voice to any idea that comes to mind in their own thoughts or is stimulated by the comments of the others at the meeting. Perhaps the most important ingredient is that all ideas are stated without criticism or evaluation. Each is simply accepted for what it is; analysis and evaluation of ideas come later or in a separate session.

Many testimonials have been offered about the value of brainstorming, often with an example or anecdote showing that some valuable ideas were produced in a brainstorming session. However, hardly any systematic research has been performed to demonstrate the value of this technique, particularly in comparison with other problem-solving methods. One such study performed by Taylor, Berry, and Block[2] under the auspices of the Office of Naval Research raises some fundamental questions about the efficacy of brainstorming. In this study the number and quality of ideas produced by individuals working in small groups and brainstorming a problem were compared with the number and quality of ideas produced by the same number of people working as individuals. Theoretically, if brainstorming is of value, more and better ideas should be produced in its group approach. In this particular study, such was not the case, though in some respects the group was superior working in a brainstorming setting.

While one study does not clearly indicate that brainstorming is of no value, such findings suggest that more thought and study should be given to this technique before any conclusion is reached that it is a worthwhile approach. It may well be that the brainstorming approach is of real value but only in certain settings, with individuals of a certain level of intelligence, and when rather specific kinds of problems are being treated. Some evidence already suggests that brainstorming requires a rather high level of intelligence to be successful. It is also possible that a brainstorming group may not be effective in an organizational environment which places restrictions upon the freedom with which people can express themselves in their routine, daily existence.

In other words, it may well be that brainstorming is valuable in advertising agencies where ideas are expressed freely and interaction is rather lively. It may be quite another matter, however, to attempt such an approach in a climate where one's status in an organization clearly dictates the extent to which ideas will be accepted or listened to. And engineering problems may be difficult to brainstorm, since engineers as a group tend to be weak in language skills and do not always think and express themselves as quickly as seems to be demanded in brainstorming.

On the other hand, group problem-solving approaches such as brainstorming have a definite value as a means of getting individuals involved in a problem, of stimulating their thinking, and of allowing them to participate in the solution. This not only allows people to cross-fertilize their ideas and add to group cohesiveness, but also reassures them that they can make a contribution, that their ideas do have some merit. And it may well be that such group participation methods should be preliminary approaches—used to "kick off" a problem-solving campaign in which individuals can then take longer periods to develop ideas and to work out full programs. Social psychologists have shown that there is no such thing as a "group mind" or "groupthink." There are only individuals who think. But when co-operating with each other or stimulated by each other, all can improve the caliber and productivity of their own thinking and arrive at solutions to problems. Brainstorming may be a valuable technique when used appropriately. However, much more systematic research is needed before we can draw firmer conclusions about its value.

REFERENCES

1. A. F. Osborn—*Applied Imagination*, Charles Scribner's Sons Inc., New York, 1957 (Revised Edition).
2. D. W. Taylor, P. C. Berry, and C. H. Block—*Does Group Participation When Using Brainstorming Facilitate or Inhibit Creative Thinking*, Department of Industrial Administration and Department of Psychology, Yale University, New Haven, Conn., November, 1957.

Graphic analysis of

HELICAL GEARS

simplifies helix angle computations

By JOHN H. GLOVER
Product Design Engineer
Transmission and Chassis Div.
Ford Motor Co.
Detroit, Mich.

WHEN power is transmitted across nonintersecting shafts, helical gears are commonly used. In such applications, the axes position, normal diametral pitch, and number of teeth in the gears are usually specified.

For assemblies where the shafts are nonparallel, crossed-axes helical gears must be used and, when an exact center distance is required, the specified conditions lead to an indeterminate equation for the evaluation of helix angles.

Several graphical and analytical approaches have been devised to approximate these angles. This new method combines the ease of a graphical solution with the accuracy of an analytical solution to provide a simple and precise procedure. With Newton's method of successive approximations, a first approximation, obtained graphically, is refined to give the helix angles to any required degree of accuracy.

Here, graphical constructions and formulations are developed for the general case, Fig. 1, where the shafts cross at any angle. However, since many assemblies which employ helical gears have shafts which cross at 90 deg, the right-angle arrangement is developed as an example problem.

First Approximation: Determination of the helix angle for a first approximation is obtained by locating graphically the common tooth tangent at the intersection of the pitch circles.

The schematic diagram, Fig. 1, shows this general case. The construction method is based on the general equation for the center distance C between gears:

$$\frac{N_1}{P_n \cos \psi_1} + \frac{N_2}{P_n \cos(\Sigma - \psi_1)} = 2C \qquad (1)$$

where N_1 = number of teeth on gear 1, N_2 = number of teeth on gear 2, P_n = normal diametral

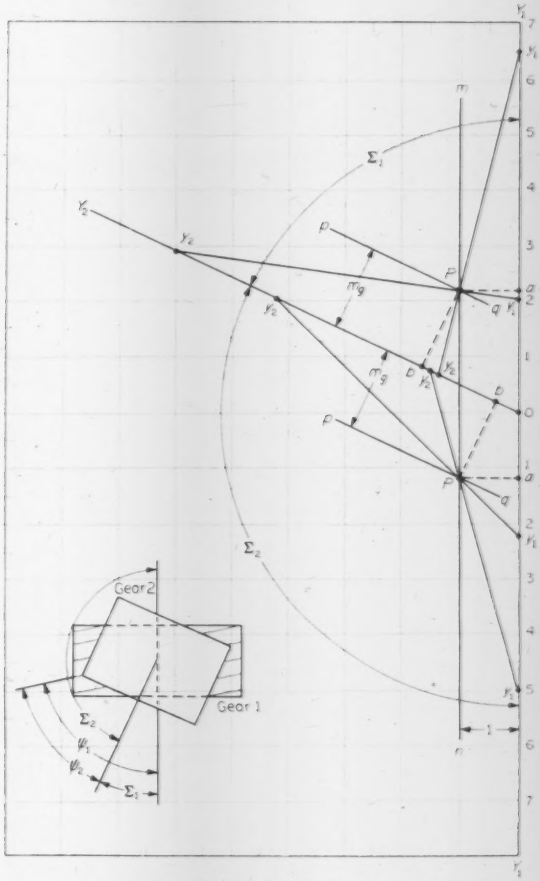


Fig. 1—Schematic of meshing helical gears and graphic representation of helix angles. Nonintersecting shafts cross at angle Σ. Helix angles ψ_1 and ψ_2 are dependent upon shaft angle, tooth ratio, normal diametral pitch, and the given distance between gear centers, and are measured from a line oriented in the position of the common tooth tangent at the pitch point

pitch, Σ = shaft angle, and ψ_1 = pitch helix angle of gear 1. Gear 1 has the smaller number of teeth in the combination, gear 2 has the larger number.

By letting m_g denote the tooth ratio, N_2/N_1, and multiplying Equation 1 by P_n/N_1,

$$\sec \psi_1 + m_g \sec(\Sigma - \psi_1) = \frac{2CP_n}{N_1} = A \qquad (2)$$

To solve Equation 2 graphically, Fig. 1, a line Y_1 $0Y_1$ is drawn to represent a line perpendicular to the axis of gear 1. From 0, $0Y_2$ is drawn at an angle with $0Y_1$ equal to the shaft angle Σ. Line $0Y_2$ represents a perpendicular to the axis of gear 2. The shaft angle may be interpreted as either acute angle Σ_1, or obtuse angle Σ_2.

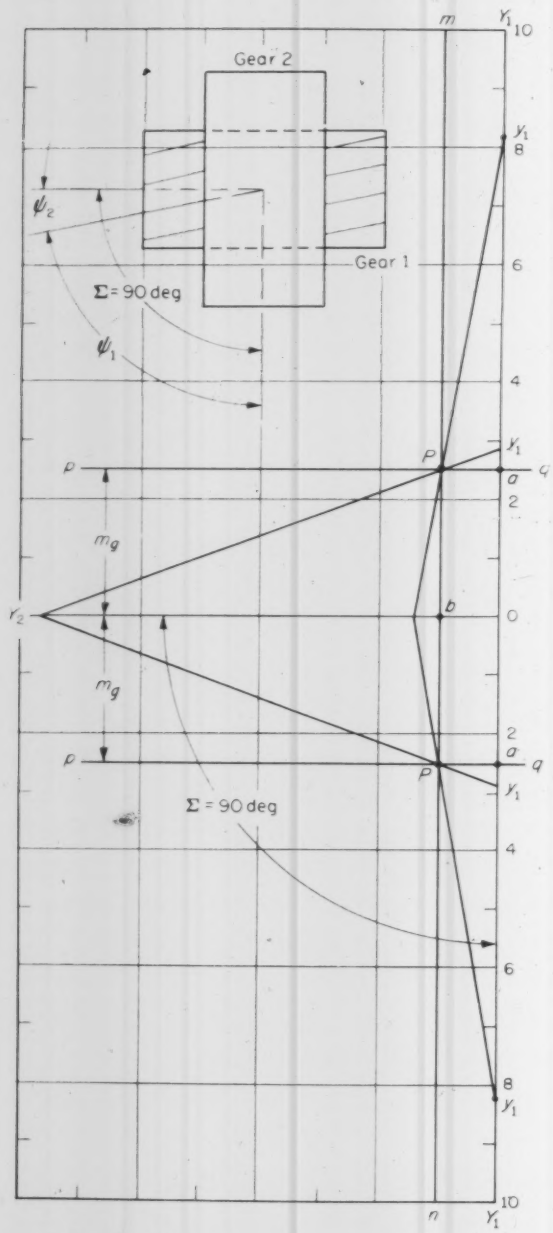


Fig. 2—Helical gears with axes at 90 deg. Schematic diagram and graphic construction aid in finding helix angles for this common arrangement

Lines $0Y_1$ are marked off in units starting at 0. Next, line mn is drawn parallel to $0Y_1$ at a distance of one unit on the Y_2 side of $0Y_1$. Then line pq is drawn parallel to $0Y_2$ at a perpendicular distance m_g on the Y_1 side of $0Y_2$. Lines mn and pq intersect at point P.

Perpendiculars are constructed to $0Y_1$ and $0Y_2$ from P. These lines intersect $0Y_1$ and $0Y_2$ at a and b, respectively. Next, a straight line A units long is directed through P in such a manner that its extremities touch $0Y_1$ and $0Y_2$ at y_1 and y_2, respectively. Thus, Pa and Pb are parallel to the axes of gears 1 and 2 respectively. Therefore, Py_1 and Py_2 are inclined to Pa and Pb at the angles ψ_1 and ψ_2 respectively and represent the tooth tangents at the pitch point P. Py_1 and Py_2 are segments of the same straight line, and therefore this line, y_1y_2, represents the common tooth tangent at the pitch point. From these relationships, segment Py_1 + segment Py_2 = y_1y_2, and sec (aPy_1) + m_g sec (bPy_2) = A. Therefore angle (aPy_1) = ψ_1 and angle (bPy_2) = $\Sigma - \psi_1 = \psi_2$. Hence, Equation 2 is solved graphically.

Choice of Solution: If a solution is possible from the given data, in general there will be four positions, two for Σ_1 and two for Σ_2, of line y_1y_2 which will satisfy the conditions. The solutions occur in pairs however, and it is possible for a pair to be coincident. The position of y_1y_2 which gives the most desirable helix angles for the particular application is, of course, the one that should be selected. Note that the graphical method gives a survey of all possibilities, from which a choice can be made for an exact solution.

Sign Convention: The shaft angle is always considered positive. The sign of $aPy_1 = \psi_1$ is plus if y_1 lies toward Y_1 from a and minus if y_1 lies toward 0 from a. The sign of $\Sigma - \psi_1$ is determined from the conventions established for the signs of Σ and ψ_1. Like signs for ψ_1 and ψ_2 indicate angles of the same hand, unlike signs indicate angles of different hand.

Successive Approximations: To arrive at an equation suitable for use with Newton's method, Equation 2 is multiplied by $\cos \psi_1 \cos (\Sigma - \psi_1)$ to obtain

$$\cos (\Sigma - \psi_1) + m_g \cos \psi_1 = A \cos \psi_1 \cos (\Sigma - \psi_1) \qquad (3)$$

By rearranging terms, dividing by $\cos \psi_1$, and letting Equation 3 be a function of the tangent of the helix angle,

$$F(\tan \psi_1) = \cos \Sigma + \sin \Sigma \tan \psi_1 - A \cos \Sigma \cos \psi_1 - A \sin \Sigma \sin \psi_1 + m_g \qquad (4)$$

from which, the first derivative of Equation 4 with respect to the tangent function becomes

$$F'(\tan\psi_1) = \sin\Sigma + A\cos\Sigma\sin\psi_1\cos^2\psi_1 - A\sin\Sigma\cos^3\psi_1 \quad (5)$$

Hence, Newton's equation for successive approximations of the helix angle can be written as

$$(\tan\psi_1)_{n+1} = (\tan\psi_1)_n - [F(\tan\psi_1)_n/F'(\tan\psi_1)_n] \quad (6)$$

in which $(\tan\psi_1)_{n+1}$ = the second approximation and $(\tan\psi_1)_n$ = the first approximation.

From the graphical solution, $\tan\psi_1 = ay_1/Pa = ay_1/1$ and can be obtained from

$$(\tan\psi_1)_n = \text{Scale reading } 0y_1 - \text{scale reading } 0a \quad (7)$$

In general terms, the value of each successive approximation can be obtained from the preceding approximation:

$$(\tan\psi_1)_{n+1} = (\tan\psi_1)_n - \left[\frac{\cos\Sigma + m_g + \sin\Sigma(\tan\psi_1)_n}{\sin\Sigma + A(\cos^3\psi_1)_n[\cos\Sigma(\tan\psi_1)_n - \sin\Sigma]} - \frac{A(\cos\psi_1)_n[\cos\Sigma + \sin\Sigma(\tan\psi_1)_n]}{\sin\Sigma + A(\cos^3\psi_1)_n[\cos\Sigma(\tan\psi_1)_n - \sin\Sigma]}\right] \quad (8)$$

Hence, successive application of Equation 8 gives helix angles to any desired degree of accuracy after the first approximation is obtained from the graphical solution. For the special case when shaft angle = 90 deg Equation 8 reduces to

$$(\tan\psi_1)_{n+1} = (\tan\psi_1)_n - \frac{m_g + (\tan\psi_1)_n - A(\sin\psi_1)_n}{1 - A(\cos^3\psi_1)_n} \quad (9)$$

Design Example: To illustrate the general procedure for determining helix angles by this method and to exemplify the more common shaft arrangement, a pair of helical gears mating at 90 deg is considered.

The mating helical gears, Fig. 2, have the characteristics, $N_1 = 8$, $N_2 = 20$, $\Sigma = 90$ deg, $P_n = 25$, and it is necessary to find the helix angles ψ_1 and ψ_2 to satisfy a center distance $C = 1.320$.

Line y_1y_2 representing the orientation of the common tooth tangent at the pitch point is found by the general construction method previously discussed. Values of $A = 2CP_n/N_1 = 2(1.320)(25)/8 = 8.25$ and $m_g = N_2/N_1 = 20/8 = 2.5$ were determined for construction of Fig. 2.

It is seen from Fig. 2 that there are four possible solutions, two of which are identical. Hence, from the graph and Equation 7, the first approximation is $(\tan\psi_1)_n$ = scale value $0y_1$ − scale value $0a = 8.15 - 2.5 = 5.65$, or $(\tan\psi_1)_n = 2.8 - 2.5 = 0.3$. Selecting $(\tan\psi_1)_n = 5.65$, $(\cos\psi_1)_n = 0.174278$ and $(\sin\psi_1)_n = 0.9846957$.

From Equation 9 the second approximation is

$$(\tan\psi_1)_{n+1} = (\tan\psi_1)_n - \frac{m_g + (\tan\psi_1)_n - A(\sin\psi_1)_n}{1 - A(\cos^3\psi_1)_n}$$

$$= 5.65 - \frac{2.5 + 5.65 - 8.25(0.984696)}{1 - 8.25(0.174278)^3}$$

$$= 5.62254 \quad (10)$$

With this value, $(\cos\psi_1)_{n+1} = 0.175341$ and $(\sin\psi_1)_{n+1} = 0.984549$ are calculated, and the third approximation is

$$(\tan\psi_1)_{n+2} = (\tan\psi_1)_{n+1} - \frac{m_g + (\tan\psi_1)_{n+1} - A(\sin\psi_1)_{n+1}}{1 - A(\cos^3\psi_1)_{n+1}}$$

$$= 5.62254 - \frac{2.5 + 5.62254 - 8.25(0.984549)}{1 - 8.25(0.175341)^3}$$

$$= 5.62253 \quad (11)$$

In a like manner, a fourth approximation, $(\tan\psi_1)_{n+3} = 5.62253$, is obtained. Since the value of this approximation is the same as the third, the value is the closest possible to four decimal places. From this approximation, the values of the helix angles are determined as $\psi_1 = 79°54'54''$ and $\psi_2 = \Sigma - \psi_1 = 10°5'6''$.

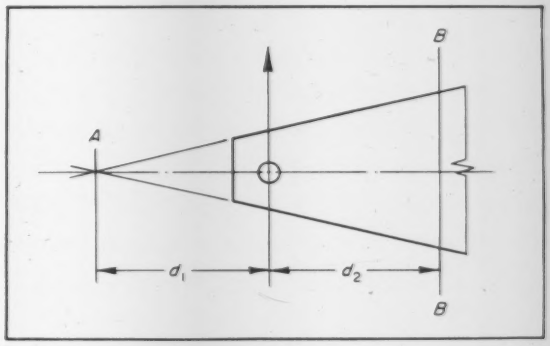
EDITOR'S NOTE

This method for determining helix angles is general and simple. Yet it provides results to any desired degree of accuracy. Alternatively, an analytical solution for the special right-angle gear arrangement is presented in "Designing Right-Angle Helical Gears" by Oliver Saari, MACHINE DESIGN, July 1953, pp. 145-148.

Tips and Techniques

Finding Critical Section

A useful stunt, mathematically derived, can save time in designing tapered cantilever beams. The method permits the critical section to be located easily and, by computing the stress at this one section, the designer is assured that the stresses



at any other section will be lower. If the computed stress at this critical section is too high, the proportions of the beam may be changed graphically until the stress is below the allowable.

Extend edges of the beam to point A, then measure distance d_1, and make $d_2 = d_1$. The critical section is located at line B-B. — PAUL HILLEGAS, *Downey, Calif.*

Chemical Prepaint Treatments for Metal Surfaces

What they do, the types available, how they are applied

By J. H. GEYER
Manager, Product Development Dept., AMCHEM PRODUCTS, INC.

Paint systems have been steadily improved in an effort to produce more decorative, easier-to-apply, and more corrosion-resistant films. The ability, however, of any paint film to perform its predetermined functions cannot be fully utilized without properly preparing the metal surface.

The prepaint preparation of the metal surface is therefore a highly important part of the system. Chemical prepaint treatments are designed to do four jobs and do them well. First, they remove organic soils, shop dirt, scale, and rust or corrosion products from the metal surface. Second, they provide surfaces that are completely compatible with subsequent paint films. Third, they produce a *tooth* that promotes good paint film adhesion. Fourth, they effectively prevent underpaint corrosion growth after any breakthrough in the paint film.

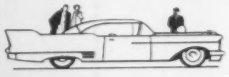
Basically, there are four types of chemical prepaint treatments. These are phosphoric acid, iron phosphate, zinc phosphate, and amorphous phosphate or chromate. Each is discussed briefly in the following paragraphs.

Phosphoric Acid

Perhaps the most widely used and certainly one of the most economical chemical prepaint treatments is the phosphoric acid cleaner combination materials. ACP Deoxidine® is such a material. It removes organic soils, rust, scale and contaminating elements from the metal surface. It also produces a light etch on steel, aluminum or zinc surfaces which considerably aids in increasing paint adhesion. It does not, however, form an actual coating on the metal surface. Any breakthrough in the subsequent paint film will permit underfilm corrosion to proceed. Grades of Deoxidine are available for application by brush or swab, hot and cold dip, or hot spray.

Iron Phosphate

Iron phosphating processes are extensively used in the chemical prepaint treatment of appliances such as water heater shells, ranges, washers, dryers and other *white lines*. These processes will produce excellent paint-bonding films on the metal and retard or prevent underpaint corrosion. Duridine,® ACP's iron phosphating process, is a combination organic soil cleaner and iron phosphate coating material. Both the cleaning and coating operations take place in the same bath. Duridine and other iron phosphates do not lend themselves to brush-on application, are primarily designed for spray type equipment of four or five stages. But several dip installations are successfully operating today by inclusion of an alkali precleaning stage.



Zinc Phosphate

ACP Granodine® is an example of this type of chemical prepaint treatment process, the type now being used to treat steel in the automotive industry, and predominantly specified for steel ordnance and military items. This process forms a coating which offers the ultimate in paint adhesion promotion and vastly augments the corrosion resistance of subsequent paint films. Zinc phosphate materials are extremely flexible as to method of application—can be applied by brush, dip or automatic spray equipment. In a typical dip or power spray system, the stages would be alkali clean, water rinse, zinc phosphate treatment, water rinse, and acidulated final rinse. If the metal has considerable areas of rust or scale, an acid pickle is advisable following the alkali cleaning stage.

On zinc surfaces, the zinc phosphates perform a rather unique function. They act as a barrier against chemical reaction between the applied paint film and the zinc surface. This effectively prevents blistering of the paint and early breakdown of the film. This is in addition, of course, to the improvement of paint adhesion and the retarding of underpaint corrosion. ACP Lithoform® is specially designed for use over zinc surfaces and finds wide application as a prepaint treatment for ornamental zinc die castings, refrigerator liners, and on most galvanized work requiring painted finishes.

Amorphous Phosphate and Chromate

These coatings are the films produced by the ACP Alodine processes and similar ones on aluminum surfaces. They have met with wide acceptance in the prepaint treatment of venetian blind strips, refrigerator liners, aluminum heat transfer units, aircraft sheet metal assemblies, and many other items fabricated from aluminum. The various coatings provide an excellent film for the promotion of paint adhesion and effectively prevent underfilm corrosion. As in the case of zinc, aluminum exhibits a tendency to chemically react with some paint systems. The Alodine processes develop a barrier film between the paint and the aluminum surfaces which prevents this reaction. The Alodines are extremely versatile materials that can be applied to aluminum surfaces by brush, hand spray, dipping, mechanical spraying, or roller coating equipment. Brush application is particularly well adapted to the processing of parts too large for simple dip systems or in manufacturing operations that do not warrant a tank setup. In dip, spray or roller coating application, the system usually consists of an alkaline preclean, a water rinse, the Alodine treatment, a water rinse, and an acidulated final rinse. Where the surface is heavily oxidized, a deoxidizer in the line is needed.

The major chemical prepaint treatments for metals have been covered briefly in this article. More complete information can be had by contacting an ACP sales representative or by writing us at Ambler, Pa.

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Circle 484 on Page 19

DESIGN ABSTRACTS

electrical

A High-Speed Logic System

H. D. Crane, Stanford Research Institute

Analysis of a logic system which uses only magnetic elements and connecting wire. A practical system for the proper interconnection of these elements is outlined. Resulting circuits are relatively inexpensive and provide unilateral information-flow properties without using explicit unilateral devices such as diodes. Inherent nondestructive "read properties" allow a great deal of logic design freedom.

AIEE paper "A High Speed Logic System Using Magnetic Elements and Connecting Wire Only," Special Technical Conference on Nonlinear Magnetics and Magnetic Amplifiers, Los Angeles, August, 1958; 18 pp.

Design of Heating Coils

D. Stuhlbarg, The Procter & Gamble Co.

A discussion of thermal design and some phases of physical design of heating coils for storage tanks. Methods for calculating heat losses, formulas for determining coil area, and factors affecting coil layout and location are covered. Results are usable in other applications.

ASME paper 58-HT-1, ASME-AIChE Joint Heat Transfer Conference, Evanston, Ill., August, 1958; 24 pp.

Effectiveness of a Transistor Cap As a Heat Dissipator

A. D. Kraus, Sperry Gyroscope Co.

An approach to the problem of providing an artificial cooling system in electronic equipment which will limit transistor junction temperature to a low value. A derivation for fin effectiveness of a transistor cap is included, and use of this parameter in predicting case temperatures is illustrated.

ASME paper 58-HT-15, from ASME-AIChE Joint Heat Transfer Conference, Chicago, August, 1958; 17 pp.

Predicting Vacuum-Tube Bulb Temperatures

M. Goldberg, Sperry Gyroscope Co.

Development of an equation which relates the heat transfer coefficient to other variables and which permits determination of maximum bulb temperatures in amplifier design. Methods of evaluating the heat-transfer coefficient and tube-envelope temperature are presented in the case of a vacuum-tube amplifier containing subminiature triodes.

ASME paper 58-HT-13, from ASME-AIChE Joint Heat Transfer Conference, Chicago, August, 1958; 15 pp.

mechanical

Plastic Deformation Of a Cantilever Beam

T. J. Mentel, University of Minnesota

A theoretical analysis of the deformation of a uniform cantilever beam with an attached tip mass. Ideal plastic-rigid behavior is assumed. The problem is investigated experimentally, and an assessment is made of theoretical work. The paper provides information on range of validity of the "ideal plastic-rigid" type of analysis. Theoretical estimate of the magnitude of effects of strain hardening and of speed of straining which are important in various tests are included.

ASME paper 58-APM-4, West Coast Conference of the Applied Mechanics Division, Los Angeles, September, 1958; 10 pp.

Structural Aspects of Re-Entry Vehicles

M. T. Braun and E. G. Czarnecki, Boeing Airplane Co.

An analysis of thermal stresses and material limitations concerning a vehicle re-entering the earth's atmosphere from orbital flight. A design arrangement for solution of structural problems using presently available techniques and materials is discussed. It is shown how a structure using a series of statically determinate trusses buckles at a low compression stress but remains relatively stress free. Conventional structures, such as honeycomb panels, are analyzed from the standpoint of applicability to this type of vehicle.

AAS paper "Structural Aspects of Earth Glide Re-Entry Vehicles," AAS Western Regional Meeting, Palo Alto, Calif., August, 1958; 14 pp.

Determining a Design Envelope For Air-to-Air Heat Exchangers

W. T. Shatzer, Douglas Aircraft Co. Inc.

A procedure for determining a near-optimum heat-exchanger design envelope. The procedure provides limits on the number of heat-exchanger core configurations evaluated, and parametric equations which represent the heat transfer

and pressure loss characteristics of various cores. It also utilizes basic equations which express the relationship between heat transfer requirements and aircraft drag.

ASME paper 58-HT-12, "Engineering Method For Determining a Design Envelope For Air-To-Air Cross-Flow Heat Exchangers," from ASME-AIChE Joint Heat Transfer Conference, Chicago, August, 1958; 23 pp.

Pitch And Curvature Corrections For Helical Springs (3 papers)

C. J. Ancker Jr., Analco Services Co., and J. N. Goodier, Stanford University

An analysis by a "thin-slice" method of tension and torsion helical springs of round cross section. Effects of curvature and pitch are included and stresses, deflections, curvature changes, diametral contractions, and couplings are discussed.

ASME paper 58-APM-10, West Coast Conference of the Applied Mechanics Division, Los Angeles, September, 1958; 5 pp.

(In Tension)

A solution to the problem of a helical spring of round cross section loaded by an axial force. Deformations and stresses are obtained by a "thin-slice" method which reduces variables from three to two. Form of these solutions is deduced from considerations of symmetry. Results, applied to the equations of boundary-value problems, produce algebraic equations which are solved.

ASME paper 58-APM-11, 13 pp.

(In Torsion)

A solution to the problem of a helical spring of round cross section loaded by an axial twisting moment. Both pitch and curvature are considered.

ASME paper 58-APM-9, 12 pp.

materials

Properties of Plastics For Photothermoelastic Studies

H. Tramposch and G. Gerard, New York University

A presentation of optical and physical properties of various plastics for use in photothermoelastic investigations. Coefficients of thermal expansion, material fringe values, and modulus of elasticity as functions of temperatures from −60 to +100 F are included. A new method for determining figures of merit in a relative manner is presented.

ASME paper 58-APM-2, from West Coast Conference of the Applied Mechanics Division, Los Angeles, September, 1958; 4 pp.

Effects of Hydraulic Fluids On Mechanical Packings

L. R. Tharp, E. F. Houghton & Co.

A classification of fluids and packing materials for the purpose of evaluating effects on each other. Effects of mineral oil on elastomers are emphasized. Methods of selecting elastomers are covered, and general recommendations are made for selection of other packing materials subjected to hydraulic fluids.

ASLE paper 58AM 6C-3, from ASLE 13th Annual Meeting, Cleveland, April, 1958; 6 pp.

Resistance and Reactance of Aluminum Conductors

W. A. Lewis, Illinois Institute of Technology, and P. D. Tuttle, Alcoa

A method for determining resistance and reactance of steel-reinforced aluminum conductors based on the magnetic characteristics of the steel core.

AIEE paper 58-1029, AIEE Pacific General Meeting, Sacramento, Calif., August, 1958; 81 pp.

techniques

Construction Of Alignment Nomograms

D. B. Kececioglu and R. W. Opperthauser, Allis-Chalmers Mfg. Co.

Techniques of converting any single Cartesian curve or a pair of curves into an alignment nomogram. Usefulness of these nomograms, especially for making repeated calculations, is pointed out. A method of accurately interpolating and extrapolating experimental data and the condition for exact conversion to alignment nomograms are discussed. Examples of how data reading may be simplified by this technique are included.

From "Construction of Alignment Nomograms and Their Application to Engineering Problems," Allis-Chalmers Electrical Review, 2nd Quarter, 1958; pp. 11-17.

Direct System Synthesis By Means of Computers

A. B. Clymer, North American Aviation Inc.

Two general methods for using a computer in conjunction with experimental results for the determination of characteristics in differential equations which represent a system. In contrast to the usual mode of application of computers, the method of implicit synthesis described here permits determination of one or more unknown characteristics in the equation when the solution and excitation are known. Systems which can be treated by these methods are those which do not readily reveal all of their characteristics when investigated by means of theory and experiment.

AIEE paper CP 58-1003, AIEE Pacific General Meeting, Sacramento, Calif., August, 1958; 23 pp.

Application of Boolean Algebra To a Heat Pump Design

H. P. Gluckman, Los Angeles Water and Power Dept., and G. J. Friedman, Servomechanisms Inc.

A presentation of the fundamentals of Boolean algebra and their application to the design of a heat-pump control circuit. It is shown how complicated control functions can be written in concise logic for Boolean equations, how these equations can be simplified by systematic methods, and how they can be translated directly into actual physical designs. The method eliminates unnecessary components in a circuit, and insures that the control system is economical.

AIEE paper CP 58-1011, AIEE Pacific General Meeting, Sacramento, Calif., August, 1958; 10 pp.

TO OBTAIN COPIES of papers or articles abstracted here, write directly to the following organizations:

ASME—American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y.; papers 25 cents to members, 50 cents to nonmembers.

Allis-Chalmers Electric Review, Milwaukee 1, Wis.

AAS—American Astronautical Society, 516 Fifth Ave., New York 36, N. Y.

ASLE—American Society of Lubrication Engineers, 84 East Randolph St., Chicago 1, Ill.; papers 35 cents to members, 50 cents to nonmembers.

AIEE—American Institute of Electrical Engineers, 33 West 39th St., New York 18, N. Y.; papers 40 cents to members, 80 cents to nonmembers.

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Circle 485 on Page 19

Helpful Literature for Design Executives

For copies of any literature listed, circle Item Number on Yellow Card — page 19

Level Transmitter

Information on a line of sealed-circuit force-balance differential pressure transmitters for level measurement is given in Specification 13D1460. 2 pages. Fischer & Porter Co., 764 Jacksonville Rd., Hatboro, Pa. E

Circle 601 on Page 19

Spherical Bearings & Rod Ends

"For You the Finest" is title of catalog sheet which outlines the features of Sperco spherical bearings and rod ends which include solid race construction and positive control linkage. Stephens-Adamson Mfg. Co., Sealmaster Bearing Div., Aurora, Ill. I

Circle 602 on Page 19

Self-Sealing Couplings

Aircraft Engineering Bulletin AEB-17 is descriptive of 3200 Series self-sealing couplings for 3000-psi hydraulic systems. Conforming to MIL-C-25427, couplings are available for ¼ to 1-in. tube sizes. 8 pages. Aeroquip Corp., Jackson, Mich. H

Circle 603 on Page 19

Photoelectric Controls

"Proved Answers to Successful Automation" is title of Bulletin PA 561. It contains specifications, operational charts, and a concise selector guide for photoelectric systems for industrial control applications. 24 pages. Electronics Corp. of America, Photoswitch Div., 1 Memorial Dr., Cambridge 42, Mass. B

Circle 604 on Page 19

Hollow Aluminum Bars

Tables giving standard sizes available in round and hexagonal hollow aluminum machining stock are contained in illustrated brochure. In addition to wall thickness, dimensions, and weights per foot, tolerances, alloys, mechanical properties, and specifications are tabulated. 8 pages. Harvey Aluminum, 19200 S. Western Ave., Torrance, Calif. L

Circle 605 on Page 19

Hydraulic Motor-Pumps

Described in Bulletin 31 are the Series T integral pump and motor units for hydraulic, pressure feed, and transfer service. They deliver 0.3 to 55 gpm and have ratings for up to 300 psi. 8 pages. Roper Hydraulics, Inc., Rockford, Ill. K

Circle 606 on Page 19

Heat-Resistant Alloy

Alloy No. 502 is a nickel-chromium-iron composition that is suited for mechanical applications requiring high resistance to heat and corrosion. Full data on this material are given in engineering bulletin. It is available in wire, rod, flats, and squares. Hoskins Mfg. Co., 4445 Lawton Ave., Detroit 8, Mich. H

Circle 607 on Page 19

Slip Rings

Slip rings ranging from 0.020 to 72 in. diameter and assemblies with rings numbering up to 100 are pictured in bulletin. Slip rings are used in stable platforms, missiles, rate tables, radar, flight simulators, centrifuges, strain gages, telemetering, and lab instrumentation. Miniature units are also shown. 8 pages. Slip Ring Co. of America, 3612 W. Jefferson Blvd., Los Angeles 16, Calif. L

Circle 608 on Page 19

Miniature Rheostat

Smaller than many 1 or 2-w potentiometers, Model E all-ceramic and metal rheostat will dissipate 12½ w. Bulletin 157 provides operating and dimensional data, as well as information on tandem assemblies, shaft locking devices, and tapered windings. 2 pages. Ohmite Mfg. Co., 3686 Howard St., Skokie, Ill. J

Circle 609 on Page 19

Speed Reducers

Line of shaft-mounted speed reducers affords single reduction units in six sizes with ratios of 5:1 and capacities to 50 hp, and double reduction drives in seven sizes with ratios of 15:1 and capacities up to 40 hp. Booklet 2618 introduces these reducers and presents tabular data on selection, dimensions, mounting, and sheave and V-belt combinations for all sizes. 24 pages. Link-Belt Co., Prudential Plaza, Chicago 1, Ill. J

Circle 610 on Page 19

Flow Switches

Series FS4 pipeline flow switches can be used to light signals, sound alarms, or start or stop motors, burners, and metering devices. Units are suitable for up to 100 psi pressures. Typical applications are shown in Bulletin FS-1. A typical air conditioning system is featured. 4 pages. McDonnell & Miller, Inc., 3500 N. Spaulding Ave., Chicago 18, Ill. I

Circle 611 on Page 19

Air Clutch

The Stationaire air-actuated clutch can be mounted anywhere along the shaft, even in the middle. Unit features stationary air housing, interchangeability with mechanical clutch applications, integral construction, and adaptability to coupling mounting. Unit is described in Bulletin 858. 8 pages. Conway Clutch Co., Cincinnati 25, Ohio. C

Circle 612 on Page 19

Rotary Selector Switch

The Ledex Model BD2E, 3½-oz subminiature rotary selector switch is described as to characteristics, dimensions, and environmental conditions covering 1, 2, 3, and 4-wafer availabilities in Bulletins 558S2 and 558ST2. G. H. Leland, Inc., 123 Webster St., Dayton 2, Ohio. G

Circle 613 on Page 19

Universal Joint Coupling

Angular and parallel misalignment are corrected by the Tru-Ax close-coupled double universal joint coupling. This coupling is described in small 1958 booklet along with helical gear speed reducers, Wedge-Lock lathe turrets, and combination rotary table and angle plate. 14 pages. Olson Industrial Products, Inc., 40 W. Water St., Wakefield, Mass. B

Circle 614 on Page 19

Special Bearings

Sample radial ball and roller, thrust, and snap ring ball bearings are shown in Folder 1057. Bearings range from precision instrument needle types to 20-in. diameter units for heavy machinery. 6 pages. Ann Arbor Bearing & Mfg. Co., 815 Wildt St., Ann Arbor, Mich. H

Circle 615 on Page 19

Planetary Motor Drive

A new planetary motor-drive for motor-driven Powerstat variable transformers is reviewed briefly in Bulletin SE-L2585. Powerstats are available in standard speeds of 5, 15, 30, and 60 seconds for full range travel. Superior Electric Co., Bristol, Conn. B

Circle 616 on Page 19

Heat Exchangers

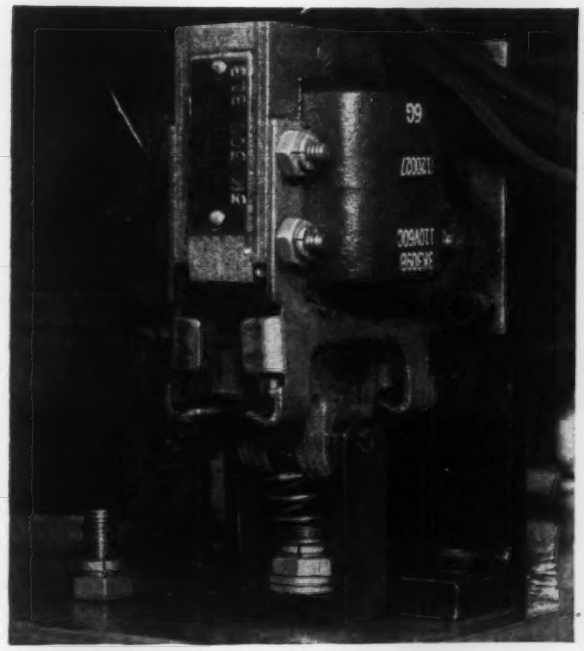
Dimensions of single, two, and four-pass fixed bundle heat exchangers are tabulated in Folder 5801-X along capacity ratings and other data. Water-water ratings range from 40,500 to 5,940,000 Btu/hr/100° F LMTD. 6 pages. Perfex Corp., 500 W. Oklahoma Ave., Milwaukee 7, Wis. K

Circle 617 on Page 19

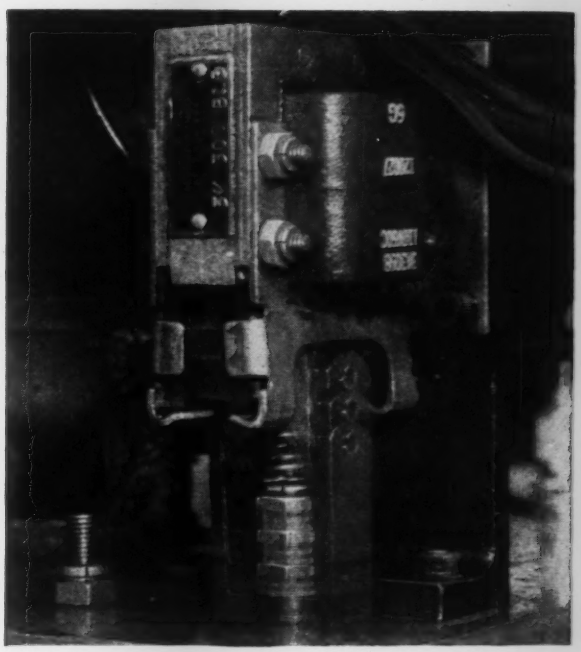
Plating Bath Heaters

Advantages of electric heat for plating baths are discussed in illustrated Bulletin GER-1333. Tips on heater selection, installation, power, and maintenance are given. 4 pages. General Electric Co., Schenectady 5, N. Y. C

Circle 618 on Page 19

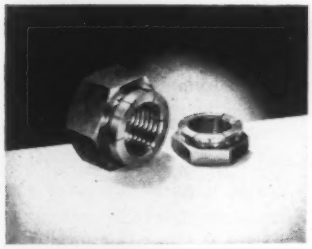


Both regular and thin height FLEXLOC nuts are used to fasten this solenoid valve assembly on a 15,000-lb.-capacity fatigue-testing machine. Valve monitors the oil supply to a control cylinder which maintains a constant load on the test specimen.



Stroboscopic photo shows action of solenoid in opening oil supply valve. Unit is capable of speeds up to 60 cycles/sec., chatters hard whenever a test specimen breaks. Despite impact and vibration, the FLEXLOC nuts never require retightening.

FLEXLOC self-locking nuts give your products greater reliability under impact, shock, vibration



Repeated shock, pounding of heavy machinery, high-speed oscillation—nothing will loosen a FLEXLOC self-locking nut. FLEXLOCS help give your assemblies the increased reliability demanded by today's higher operating temperatures, faster speeds, and greater dynamic stresses.

FLEXLOCS are available in either regular height or thin height configurations, the latter being designed for applications where space and weight savings are vital. Both are 1-piece, self-locking units requiring no auxiliary locking elements—no lockwashers, jam nuts or cotter pins. There is nothing extra to put together, come apart or get lost . . . and no nonmetallic inserts to waste head space or weaken the structure of the nut. With a FLEXLOC, every thread, including those in the locking section, carries its full share of the tensile load.

Because they require no separate locking devices, FLEXLOC self-locking nuts facilitate design and specification, simplify inventory and handling, reduce assembly time and costs. They also save on maintenance, because they are readily removed and can be reused many times with no effect on the reliability of their locking action.

Your authorized SPS distributor carries FLEXLOC self-locking nuts—regular and thin height—in all standard sizes, materials and finishes. Flexloc Locknut Division, STANDARD PRESSED STEEL CO., Jenkintown 18, Pa.

HIGH RELIABILITY

SPS research is continually developing fasteners with higher standards of predictable performance. By installing SPS high-reliability fasteners in your assemblies, you increase overall product reliability.

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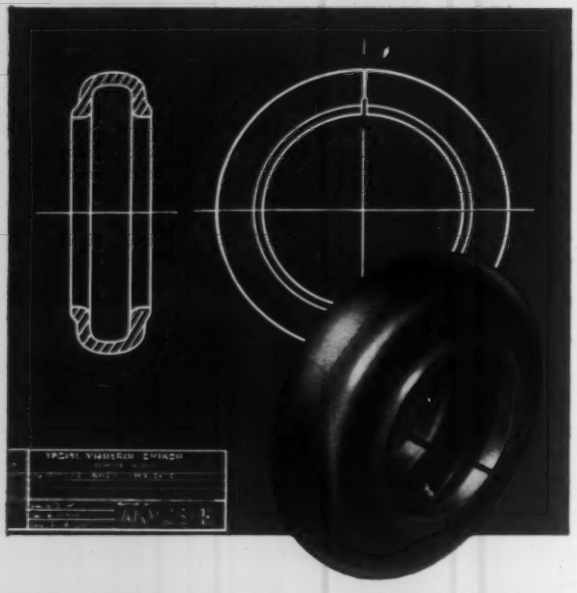
Engineering With Rubber For Improved Performance

These examples show how Dayton molded product engineers are working with mechanical designers to help them achieve new product performance standards. Pre-engineered in combinations of tension, compression and shear for exact deflection requirements, these quality Dayton molded products replace metal-to-metal parts . . . eliminating grease fittings, reducing metal wear and maintenance problems, simplifying assembly, and giving long service.



Rubber tire in this flexible coupling is held by flanges and clamp rings . . . cushions shock loads, reduces torsional vibration, and accommodates angular and parallel misalignment and end float. A transverse split is molded into the tire, permitting replacement without disturbing the shafts. No lubrication is required.

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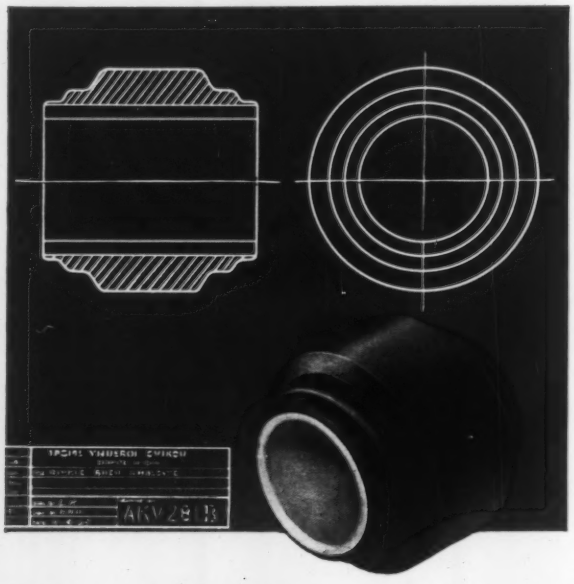

Rubber-to-metal bushing, bonded for life to its inner metal by the quality Dayton process, accommodates torsional and angular motion at the radius rod ends. It provides a flexible pivot joint, eliminating metal wear and lubrication, absorbing shock, noise and vibration. With extreme radial stiffness and maximum torsional flexibility, this bushing is easy to install and can be positioned exactly.

Engineered rubber is the answer to your needs in vibration, noise and shock control . . . inherent misalignment of mechanical elements . . . simplifying assembly problems . . . and reducing maintenance costs. Dayton has design and production facilities to give you complete service from blueprint to finished product. Consult our molded product specialists.

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Turbine Pumps

Regenerative turbine pumps for continuous high pressure pumping of nonlubricating and corrosive liquids are reviewed in Folder 2S58. Briefly described and performance-rated are chemical, low NPSH, power plant and condensate return pump units. Capacities range up to 200 gpm. 4 pages. Roy E. Roth Co., Turbine Pump Div., Rock Island, Ill. I

Circle 619 on Page 19

Hydraulic Fluid Filter

Line of 2-micron filters for hydraulic fluids, fuels, lubrication oils, air, gases, and solvents is subject of Engineering Data Sheet 100. Filters remove particles as small as 2 microns and operate in —65 to 275° F range. 2 pages. Bendix Aviation Corp., Bendix Filter Div., 434 W. 12 Mile Rd., Madison Heights, Mich. H

Circle 620 on Page 19

Stainless Steel

Sections in Brochure 561R on Enduro chromium-nickel stainless steel cover types in the 300 Series, corrosion resistance, properties, fabricating and working, joining methods, and care and finishing. Creep strength of this steel goes as high as 10,000 psi at 1200° F. 36 pages. Republic Steel Corp., Republic Bldg., Cleveland 1, Ohio. F

Circle 621 on Page 19

Place Bolts

Lamson slotted type place bolts feature built-in spring action which withstands vibration, wear, corrosion, and expansion or contraction due to temperature changes. Descriptive folder tells how to determine wrench torque for these bolts. 6 pages. Lamson & Sessions Co., 1971 W. 85th St., Cleveland 2, Ohio. G

Circle 622 on Page 19

Chains

Chains for conveying, elevating, and power transmission; chain attachments; and elevator buckets are briefly described in illustrated brochure. Special and general application products are covered. 8 pages. Moline Malleable Iron Co., St. Charles, Ill. I

Circle 623 on Page 19

Small Limit Switches

According to Micro Switch Bulletin 21, Series E6 and V6 small limit switches can be wired "in a jiffy." Six actuator designs are available for either side or bottom mounting. Folder pictures and specifies all actuator designs and gives mounting dimensions. 4 pages. Minneapolis-Honeywell Regulator Co., Micro Switch Div., Freeport, Ill. K

Circle 624 on Page 19

Conveyor Belts

Guide to proper selection of oil-resistant conveyor belts is included in Data Sheet 2460. Data on the most economical belt construction for handling material which contains oil or is treated with oil are included. 2 pages, B. F. Goodrich Industrial Products Co., Akron, Ohio. F

Circle 625 on Page 19

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FOR "FIXED" and "BLIND" fastening to get

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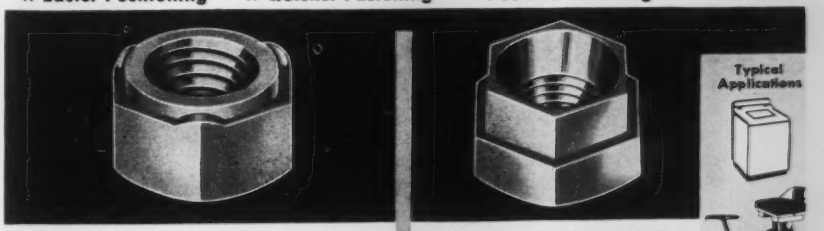

Typical Applications

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Countersunk feature eliminates time-wasting re-tapping of nut after welding. The 3 weld projections on both type nuts provide a firm non-rocking electrical connection.

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Circle 488 on Page 19

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Circle 489 on Page 19

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Circle 490 on Page 19

Rotary Positive Blowers

Revised to include new capacities and pressure ratings, Bulletin AF-258 on Type AF rotary positive blowers will aid the engineer in proper selection and application of this equipment for either vacuum or pressure installation. Capacities range as high as 825 cfm at 7 in. Hg, vacuum. 8 pages. Dresser Industries, Inc., Roots-Connersville Blower Div, 900 W. Mount St., Connersville, Ind. J

Circle 626 on Page 19

Vibrating Feeders

Complete descriptive data and specifcations are presented in Catalog 47190-2C for line of 13 standard electromagnetic vibratory feeders; three air, oil, or water powered feeders; a special spreader feeder; and heat resistant furnace feeders, dryers, preheater and cooling feeders, conveyor and elevating feeders. Typical installations are shown. 30 pages. Syntron Co., 260 Lexington Ave., Homer City, Pa. F

Circle 627 on Page 19

Ultrasonic Equipment

Short Form Catalog 104-758 gives brief specifications and illustrations of Son-Blaster ultrasonic generators, submersible transducers, and transducerized tanks. Advantages of ultrasonic cleaning, soils that can be removed, and other applications are listed. 4 pages. Narda Ultrasonics Corp., 625 Main St., Westbury, L. I., N. Y. D

Circle 628 on Page 19

Cooling Coils

Complete line of Herman Nelson direct expansion, standard and cleanable tube water cooling coils is described in detail in illustrated Bulletin 880. Construction specifications, dimensions, surface charts, and circuit diagrams are among contents. Selection data are included, along with much basic information in chart form. 48 pages. American Air Filter Co., 215 Central Ave., Louisville 8, Ky. G

Circle 629 on Page 19

Component Metal Parts

Springs, wire forms, light metal stampings, screw machine products, assemblies, and subassemblies are some of the custom-engineered products produced by this company. Details of service offered in the field of special component metal parts are outlined in Catalog SH-100. Technical data deal with spring design. Plant facilities are described. 12 pages. Stanley-Humason, Inc., Forestville, Conn. B

Circle 630 on Page 19

Storage Batteries

Design improvements in Exide-Manchex storage batteries for stationary uses are detailed in Bulletin 6205. How improved construction contributes to greater power and extended life is explained. Batteries feature suspended plates, enlarged electrolyte reservoir, and improved plastic jar. 8 pages. Electric Storage Battery Co., Exide Industrial Div., Box 8109, Philadelphia 1, Pa. E

Circle 631 on Page 19

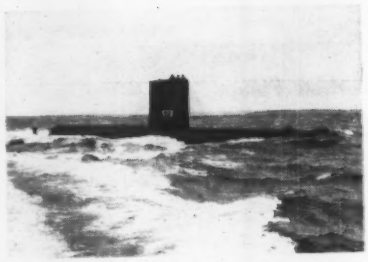

Photo courtesy Electric Boat Division of General Dynamics Corp.

U.S.S. Skate, first production model atomic sub, carries a wealth of electric, hydraulic and mechanical equipment including numerous ANGLgear standardized 90° drives.

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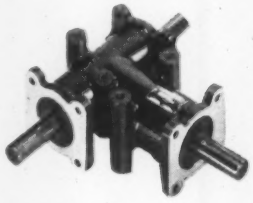
You can specify ANGLgear in 16 different stock models, ⅓ to 5 hp, with 1:1 or 2:1 gearing and 2 or 3-way shafting. See our literature in Sweet's Product Design File or contact our local distributor.



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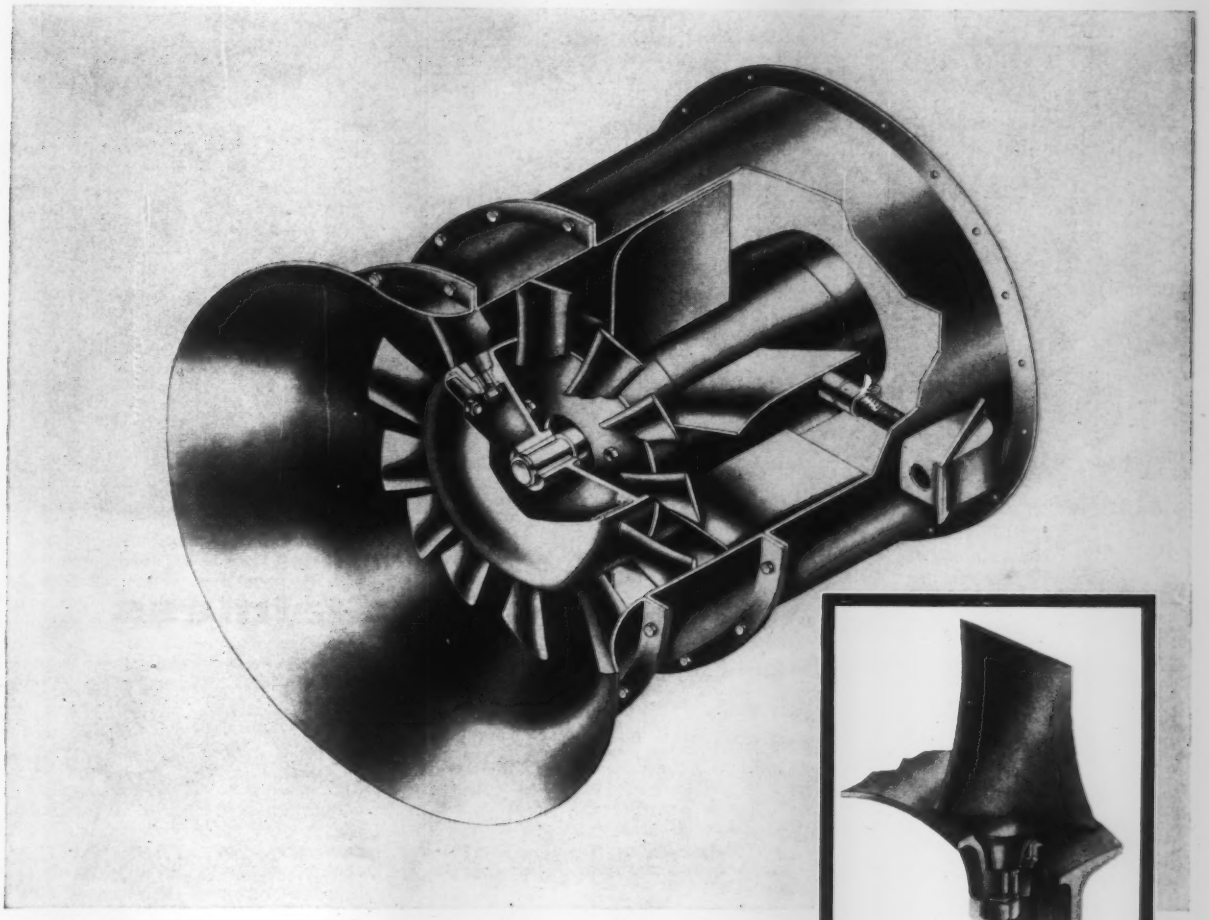
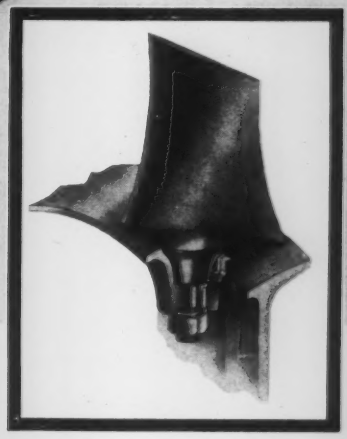
Circle 491 on Page 19





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Joy Manufacturing Company, Oliver Building, Pittsburgh, Pa. In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario.

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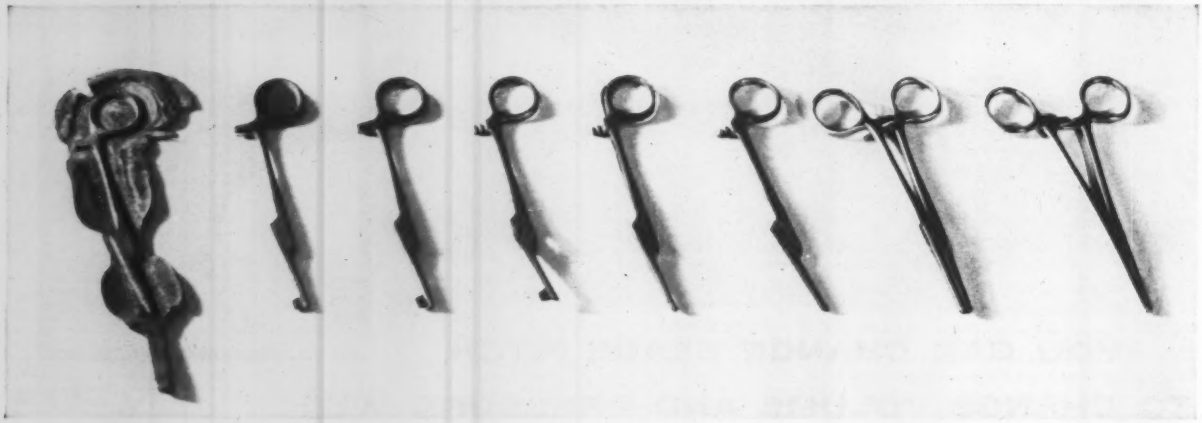


All orders for stainless steel for these artery forceps specify "Carpenter" because of "uniformity from shipment to shipment". Freedom from seams and excellent machining to close tolerances are other reasons given by the fabricator. The stainless is specially processed to meet the rigid specifications. By specifying Carpenter you can take the pressure off both designer and fabricator. High temperatures and stress variations are no longer problems. We'll back up our success stories with technical data and on-the-job service. Call your Carpenter representative for information on the stainless you need. The Carpenter Steel Company, 120 W. Bern Street, Reading, Pa.

Carpenter STEEL

The Carpenter Steel Company, Main Office and Mills, Reading, Pa.
Alloy Tube Division, Union, N. J.
Carpenter Steel of New England, Inc., Bridgeport, Conn.
Webb Wire Division, New Brunswick, N. J.

Counter-Controller

Series 320 dual preset counter-controllers, subject of illustrated bulletin, are designed for coil winding, motor speed control, shearing to length, batching, packaging, stacking by number, variable pulse interval generation, and process programming. 4 pages. Computer Measurements Corp., 5528 Vineland Ave., North Hollywood, Calif. L

Circle 632 on Page 19

Magnesium in Electronics

"Magnesium in the Electronics Industry" deals with the use of magnesium in airborne and air-transportable electronic equipment. Properties of magnesium which suit it for this service are tabulated. 20 pages. Dow Chemical Co., Midland, Mich. H

Circle 633 on Page 19

Synthetic Rubber Products

The characteristics and properties of Duthane polyurethane elastomer which adapt it for use in such applications as industrial tires; drive, feed, and printing rolls; gears; and couplings are clearly presented for the design engineer in booklet. 4 pages. Dunlop Tire & Rubber Co., Duthane Div., Box 2011, Buffalo 5, N. Y. N

Circle 634 on Page 19

Solderless Terminal Blocks

Solderless terminal blocks with taper pin solderless wiring terminations can be stacked for printed circuit and computer applications. Full details of these units are given in illustrated bulletin. 6 pages. DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. D

Circle 635 on Page 19

Analog Computer

Specifications and details of the new 80-amplifier MC-5800 master precision analog computer are included in file folder. Also described are circuit logic required for building-block flexibility, adaptability for high speed repetitive operation, and complete problem check. 18 pages. Mid-Century Instrumatic Corp., 611 Broadway, New York 12, N. Y. D

Circle 636 on Page 19

Nylon Bearings

Advantages and economies of Nylined nylon and nylon-lined bearings and liners are explained in Bulletin 209. Offered in a complete range of sizes, bearings are made in standard, flanged, snap-in, and sleeve types. Dimensions and prices are included. 10 pages. Thomson Industries, Inc., Manhasset, N. Y. D

Circle 637 on Page 19

Electro-Magnetic Relays

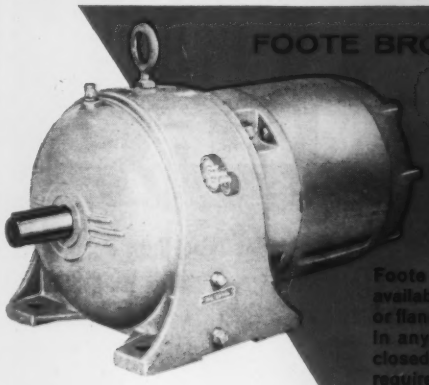
Thirty-three papers by 42 authors presented at the Sixth National Conference on Electro-Magnetic Relays are bound in booklet form for design engineers concerned with this subject. Tables, graphs, diagrams and pictures complete the text. 132 pages. Potter & Brumfield, Inc., Princeton, Ind. J

Circle 638 on Page 19

FOOTE BROS. **Motorized Drives**

Duti-Rated LIFETIME GEARING

Gives You More Power Per Dollar



FOOTE BROS.-LOUIS ALLIS

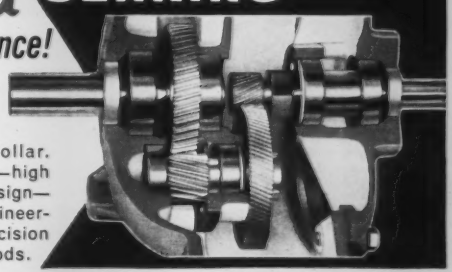
GEARMOTORS

1 to 150 HP...Single, Double, Triple, Quadruple Reductions . . . Output Speeds from 780 to 7.5 RPM

Foote Bros.-Louis Allis Gearmotors are available in over 3500 types and sizes. Foot or flange mountings. Motors can be ordered in any type—open drip-proof, totally enclosed, explosion proof, etc. to meet your requirements.

Duti-Rated GEARING

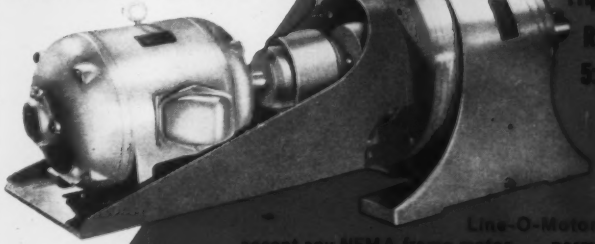
Makes the Difference!



Duti-Rated Gearing is the heart of Foote Bros. Motorized Drives . . . drives that give you more load capacity and wear life per dollar. This is premium quality gearing—high hardness, accurate, balanced design—the product of thousands of engineering and development hours, precision tooling and manufacturing methods.

FOOTE BROS.

Line-O-Motor

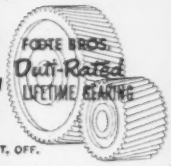


1 to 75 HP...Double, Triple Reductions... Ratios: 5:1 thru 238:1

Line-O-Motor Drives accept any NEMA frame motor . . . permit you to use your own motor or specify type to meet plant standardization. Foot or flange mounted.

Write for CATALOG MRA. It has complete details and selection data on Foote Bros. Motorized Drives.

this trademark stands for the finest industrial gearing made



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FOOTE BROS.

Better Power Transmission Through Better Gears

FOOTE BROS. GEAR AND MACHINE CORPORATION

4567 South Western Boulevard Chicago 9, Illinois

Circle 494 on Page 19

NEW handy guide to low cost quality FASTENERS

Die Cast Zinc Alloy Wing Nuts • Cap Nuts
Thumb Nuts • Thumb & Wing Screws
Molded Nylon Screws • Washers • Screw Insulators

GRC catalogs the widest range of stock styles, types, sizes and threads from one source . . . charts the dimensions of each style, type and size . . . illustrates them all with photographs and schematic drawings.

Detailed are uses, physical properties of zinc alloy and nylon, the many advantages of GRC fasteners . . . produced in one high speed automatic operation to assure quality fasteners at lowest cost.

Write, wire, phone RIGHT NOW for YOUR copy of GRC's new Fastener Bulletin.

World's Foremost Producer of Small Die Castings

GRIES

GRIES REPRODUCER CORP.
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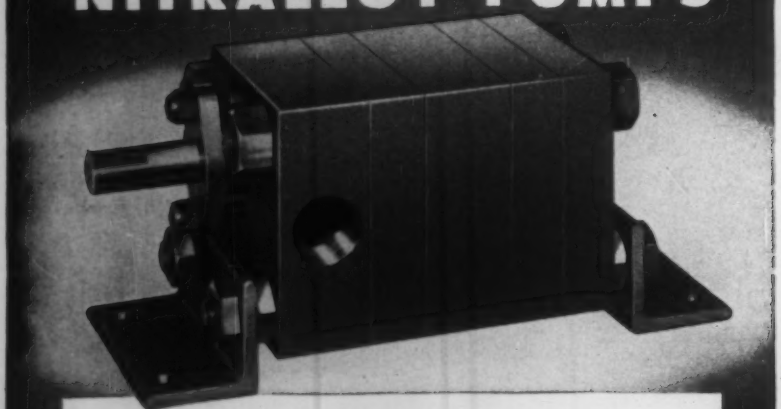
See GRC at the METAL SHOW • Booth 550

Circle 495 on Page 19

NORTHERN NITRALLOY PUMPS



Unique block construction permits selection from a wide choice of metals for virtually any pumping need. Proven in thousands of installations . . . backed by 50 years of engineering and production experience. Unexcelled for precision manufacture, accurate assembly and dependable, long-life operation. Pressures to 2,000 PSI. Capacities from ¼ to 146 GPM. *Write for free catalog and engineering data.*

NORTHERN ORDNANCE, INCORPORATED
Subsidiary
NORTHERN PUMP COMPANY
MINNEAPOLIS 21, MINN.

Circle 496 on Page 19

Precision Electric Switches

Basic, subminiature, hermetically sealed, and packaged controls are but a few of the precision electric switches discussed in Catalog 5208. Information to aid in design, engineering and application of these controls is presented. Included is a dictionary of terms as well as a technical discussion relative to precision limit switches. 32 pages. Illinois Tool Works, Licon Div., 2501 N. Keeler Ave., Chicago 39, Ill. J

Circle 639 on Page 19

Engineered Seating

Seats for stationary and mobile equipment of every type are described in illustrated brochure entitled, "Engineered Seating." Also covered are design and production facilities of this company. Data are included on rubber and foam plastic cushioning, spring construction, and seats for such equipment as trucks, tractors, cranes, earthmoving equipment, and buses. 28 pages. Bostrom Corp., 133 W. Oregon St., Milwaukee 4, Wis. K

Circle 640 on Page 19

Compression Packings

Developed to round out a complete line of molded packings and hydraulic fluids, Val-Pac compression packings are available in both sheet and rod seal types. Various materials and constructions in this line which adapt them for specific services are detailed in comprehensive catalog. Charts cite recommended uses. 24 pages. E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Pa. C

Circle 641 on Page 19

Electric Relays

Catalog 159 reports on design, engineering, and performance of standard, miniature, and subminiature relays. Data are included on telephone type, snap-action, power, 400-cycle, time delay, latch-in, and low capacitance relays. Various enclosures are available. 20 pages. Magnecraft Electric Co., 3350 W. Grand Ave., Chicago 51, Ill. I

Circle 642 on Page 19

Die Cast & Molded Parts

"Small Parts for Industry" bulletin covers a wide variety of zinc alloy die cast and molded thermoplastic products. Sections on made-to-specification parts and stocked standard parts are included. A number of Intercast movable, multiple elements parts are shown. 8 pages. Gries Reproducer Corp., 125 Beechwood Ave., New Rochelle, N. Y. D

Circle 643 on Page 19

Reinforced Neoprene Pipe

Four data sheets contain specifications, prices, and installation information on line of flexible, vibration-absorbing, wire reinforced, neoprene pipe joints. Both threaded and flanged types are available for connecting equipment and pipe lines subject to vibration or noise transmission. 2 pages each. La Favorite Rubber Mfg. Co., 275 Wagaraw Rd., Hawthorne, N. J. D

Circle 644 on Page 19

Versatile ACIPCO SPUN TUBES

Stainless steel, carbon steel, alloy iron or special analyses—versatile ACIPCO tubes are "custom-spun" to the exact physical, chemical and metallurgical specifications required by design, manufacturing and end-use conditions.

Because they are centrifugally spun, the metal grain structure of ACIPCO tubes is dense, non-directional and porosity-free. This *superior* grain structure not only makes ACIPCO tubes easier to machine to close tolerances, but also results in greater strength and durability. In addition, the inherent dimensional stability and concentricity of ACIPCO tubes make dynamic balance easier to attain in finished products.

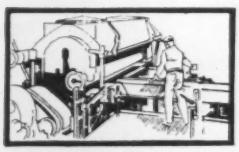
ACIPCO'S complete, integrated facilities for casting, heat-treating, machining, fabricating and testing offer the additional advantages of "one source—from start to finish" service.

Call or write today for information about ACIPCO tube applications in your field, or for expert technical assistance on your specific tubular metal problem.

SIZE RANGE: Lengths up to 410" have been produced to meet modern machinery requirements. OD's from 2.25" to 50"; wall thicknesses from .25" to 4".

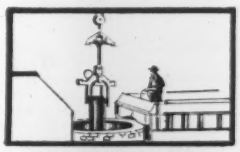
ANALYSES: All alloy grades in steel and cast iron, including heat and corrosion resistant stainless steel, plain carbon steel and special analyses.

FINISHED: As cast, rough machined, or finished machined, including honing. Complete welding and machine shop facilities for fabrication.



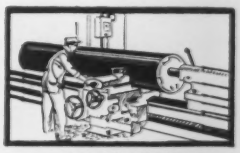
SPINNING

ACIPCO tubes are centrifugally spun to exact physical and metallurgical specifications. Thus, the exact size and metal analysis your process or project requires is assured.



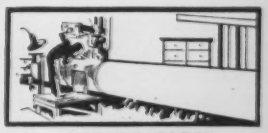
HEAT TREATING

Modern equipment for uniform, controlled heat treating and quenching is an ACIPCO advantage for users of steel tubes where specific physical, mechanical and other metal properties are required.



MACHINING

ACIPCO'S machine shop, one of the South's most completely equipped, performs a full range of machine shop operations including turning, boring, drilling, facing, grinding, metallizing, polishing and honing.



FABRICATION

Complete, integrated facilities for machining, welding, finishing and heat treating of tubular parts save time and expense for ACIPCO customers.

TECHNICAL ASSISTANCE

A staff of highly trained engineers, metallurgists, chemists, and craftsmen is available to designers and manufacturers who specify ACIPCO spun tubes.

Special Products Division

AMERICAN

CAST IRON PIPE CO.

PHONE AL 1-8121, EXT. 285 • BIRMINGHAM, ALA.

Circle 497 on Page 19

"Choose from this wide range of Gast Air Compressors", says C. E. Bradley, Ass't. Sales Mgr. "Vacuum Pumps are also available in corresponding models."

Here's high performance . . . in a full line of

GAST rotary vane COMPRESSORS and VACUUM PUMPS

When you select original equipment Air Pumps, look at the Gast Line. You'll see how your product—and budget—may benefit.

Within a well-defined range, Gast Pumps excel on hundreds of product applications. (Capacities .6 to 45 cfm.; pressures to 30 psi., vacuum to 28 in. Hg.) Precision-built primarily for O.E.M. use, they are rugged and dependable. Simple rotary-vane design maintains like-new performance for years, because vanes take up their own wear automatically. Air displacement is positive and pulseless—no air tank needed. Ball bearings and self-adjusting shaft seals keep efficiency high.

Types include: Dual-chamber (one chamber for vacuum, one for pressure), integral-motor pumps, light-duty models for moderate pressure or vacuum, and fan-cooled models for heavy-duty service. Oil-less (carbon-vane) types provide absolutely oil-free air if desired.

Submit your problem for suggestions by Gast Engineers—or . . .

Write today for Catalog on Compressors or Vacuum Pumps.
State specific type or capacity that interests you.

(1) (Front to rear) Dual Chamber Pumps:	(2) Integral-Motor Pumps for O.E.M. or Lab use:	(3) Light-Duty Models Moderate Vac./Press.	(4) Heavy-Duty Models, with Fan Cooling, V-belt or Direct Dr.
Model 11 x 1740, total to 23 cfm.	0521, 1/3 hp. to 3.8 cfm.	3040, up to 24.2 cfm.	
	0321, 1/4 hp. to 2.2 cfm.	1550, up to 15.0 cfm.	2565, to 21.0 cfm.
10 x 1040, to 18 cfm.	0211, 1/6 hp. to 1.3 cfm.	0740, up to 5.6 cfm.	1065, to 8.3 cfm.
Single (in Hand) AD-440, to .6 cfm.	0406, 1/12 hp. to .6 cfm.	0440, up to 4.0 cfm.	0465, to 4.0 cfm.
		0240, up to 2.0 cfm.	4565, to 45.0 cfm.

GAST MANUFACTURING CORP., P.O. Box 117-P, Benton Harbor, Michigan

SEE CATALOG IN SWEET'S PRODUCT DESIGN FILE & A.S.M.E. CATALOG

GAST ROTARY

- AIR MOTORS TO 7 H.P.
- COMPRESSORS TO 30 P.S.I.
- VACUUM PUMPS TO 28 IN.

"Air may be your answer!"

Magnetic Flow Meters

Two new magnetic flow meters for 1/10 and 3/16-in. lines permit measurement of full scale flow rates as low as 0.1 gpm. Typical corrosive or "difficult" liquids which can be handled are listed, and applications of meter are covered in Bulletin 20-14C. 2 pages. Foxboro Co., Foxboro, Mass. B

Circle 645 on Page 19

Steel Pipe & Fittings

Light wall construction plus fast positive coupling are features of Quick Pipe which adapt it for industrial use in conveying water, air, oil, or chemicals. Pipe, couplings, valves, and fittings are detailed in bulletin. 4 pages. R. H. Pierce Mfg. Co., Industrial Div., Eugene, Oreg. M

Circle 646 on Page 19

Molded Cable Assemblies

Molded cable assemblies equipped with straight and right-angle phone plugs and Tini-Plugs, phone extension jacks, and phonograph plugs and extension jacks are shown and described in Catalog Supplement S-592. 4 pages. Switchcraft, Inc., 5555 N. Elston Ave., Chicago 30, Ill. I

Circle 647 on Page 19

Centrifugal Pumps

Offered in 33 sizes with capacities from 200 to 6400 gpm and for heads to 425 ft, Fig. 3405 centrifugal pumps feature single stage, double suction, horizontally split casing design. Complete specifications are given in Bulletin 721.6. 16 pages. Goulds Pumps, Inc., 47 Black Brook Rd., Seneca Falls, N. Y. D

Circle 648 on Page 19

Tool Steels

Carbon, alloy, and high speed tool steel AISI type-brand name comparison chart lists 43 brand names produced by this company and other producers. High speed, hot work, tool and die, shock and special purpose, plastic mold, carbon, and carbon vanadium are categories covered. H. K. Porter Co., Vulcan-Kidd Steel Div., Aliquippa, Pa. N

Circle 649 on Page 19

Wire Markers

Illustrated and described in catalog are various pressure-sensitive Speedy-Marx wire markers, offered in two sizes. Types with solid numbers, letters, symbols, solid NEMA colors, machine tool symbols, and consecutive numbers are covered. 8 pages. North Shore Nameplate Inc., 214-27 Northern Blvd., Bayside 61, N. Y. D

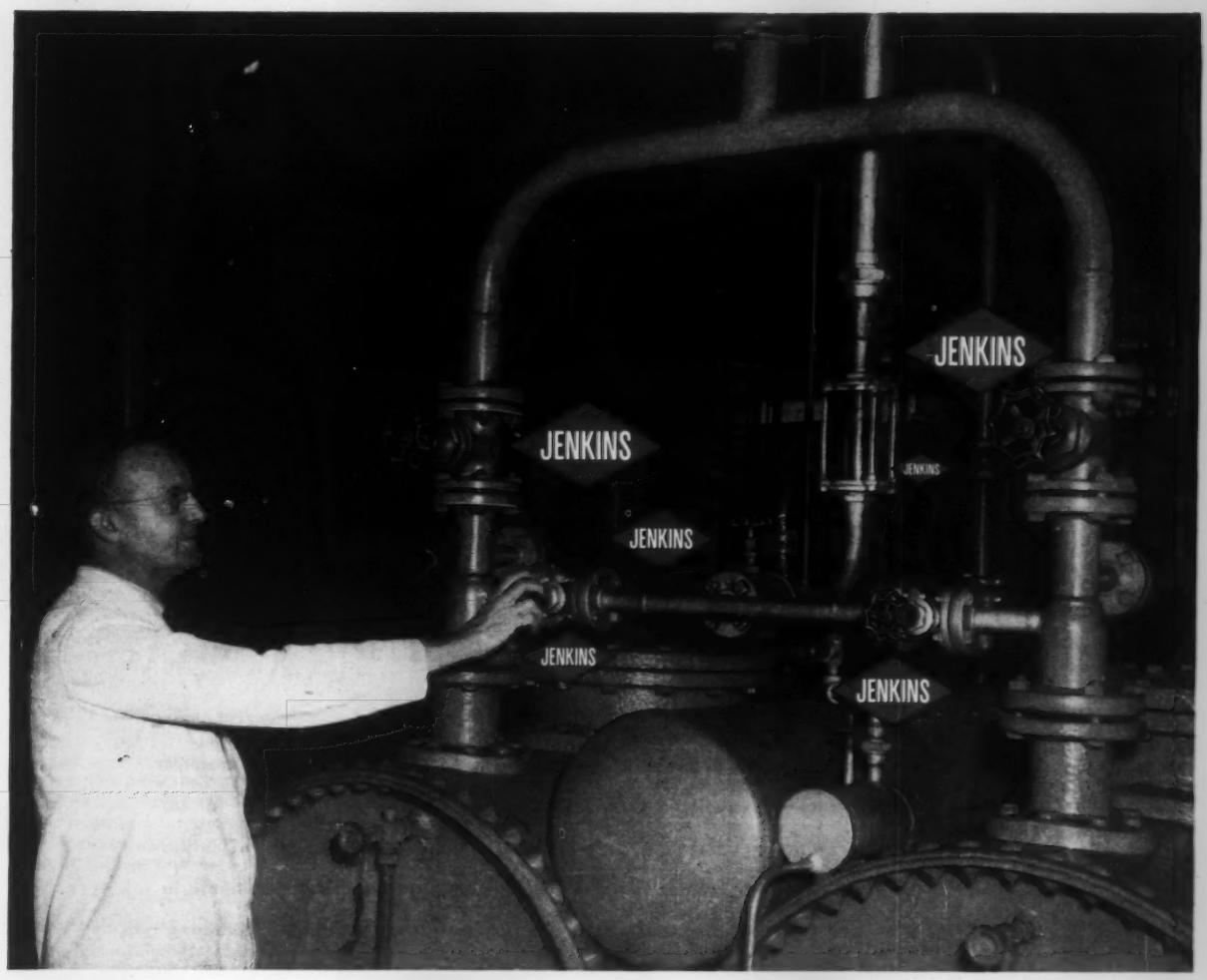
Circle 650 on Page 19

Midget Valves & Fittings

Minimum capacity in capillary and small diameter high pressure tubing systems is provided by line of midget valves and fittings, subject of illustrated Catalog 658. They offer a wide range of mechanical seals and controls. Four standard tubing connections are offered. 8 pages. High Pressure Equipment Co., 1222 Linden Ave., Erie, Pa. F

Circle 651 on Page 19

Circle 498 on Page 19



No Stinting on Quality Here

For equipment you design, provide valves that say: ***No stinting on quality here.*** Provide valves which all your customers associate with top quality . . . the same valves many insist on for their plant piping . . . the valves marked with the famous Jenkins *Diamond*. Despite their reputation for long, dependable performance, with a minimum of costly and annoying maintenance, Jenkins Valves *cost no more* than any good valves.

Write us for information about the types of valves you require. Jenkins Bros., 100 Park Ave., New York 17.

SOLD THROUGH LEADING DISTRIBUTORS EVERYWHERE

JENKINS
LOOK FOR THE JENKINS DIAMOND
VALVES
JENKINS
SINCE 1864
Jenkins Bros

MECHANICAL ENGINEERS
ELECTRICAL ENGINEERS

Challenging job opportunity on the editorial staff of MACHINE DESIGN

Here's your chance to break in on a growing field where aggressive creative work is really appreciated. MACHINE DESIGN has a staff opening for an engineer with an interest in both engineering and editorial work. This job provides stimulating contact with many engineering areas plus opportunity to grow and progress as a specialist in a particular branch of design engineering.

Some evidence of design engineering experience is necessary, and an ME or EE degree would be desirable. Writing ability and interest are also required, although a heavy background of editing or writing is not essential.

Salary will depend on experience; progress for the right man can be rapid. Headquarters are in Cleveland with opportunities for travel to attend engineering meetings and expositions.

If you are interested, send full details of your engineering background to the Editor, MACHINE DESIGN, Penton Building, Cleveland 13, Ohio.

Shaft Couplings

Dimensional drawings, specifications, design details, and prices of Sphere Gear shaft couplings are presented in illustrated folder and data sheets. Used to solve shaft misalignment problems, they are offered in several styles. Dykman Mfg. Co., 320 Broadway, New York 7, N. Y. D

Circle 652 on Page 19

Thermostats

Operating principle of both hermetically sealed and semienclosed types of Stemco Type C thermostats is described on illustrated Bulletin 5000. Schematic diagrams, performance data ratings, and dimensions are given. 2 pages. Stevens Mfg. Co., Box 1007, Mansfield, Ohio. G

Circle 653 on Page 19

Mechanical Tubing

Cold drawn mechanical tubing with smooth inside finish for hydraulic cylinders is subject of Bulletin TB-428. Its specifications, how it is inspected, and available sizes are detailed. 6 pages. Babcock & Wilcox Co., Tubular Products Div., Beaver Falls, Pa. G

Circle 654 on Page 19

Mercury Switches

Twelve popular styles of mercury switches are described and illustrated in folder which presents their specifications. They feature heat and spark resistant glass bodies and mercury-to-mercury contact. 4 pages. American Designed Components, Inc., Jericho, L. I., N. Y. D

Circle 655 on Page 19

Armored Cabled Tubes

"Crescent Armored Multitube" is illustrated technical bulletin on cabled tubes for instruments and controls. Various types of tubing, protective armor, and types of corrosion resistant sheaths, plus installation instructions, are covered. Accessories are illustrated. 12 pages. Crescent Insulated Wire & Cable Co., Trenton 5, N. J. E

Circle 656 on Page 19

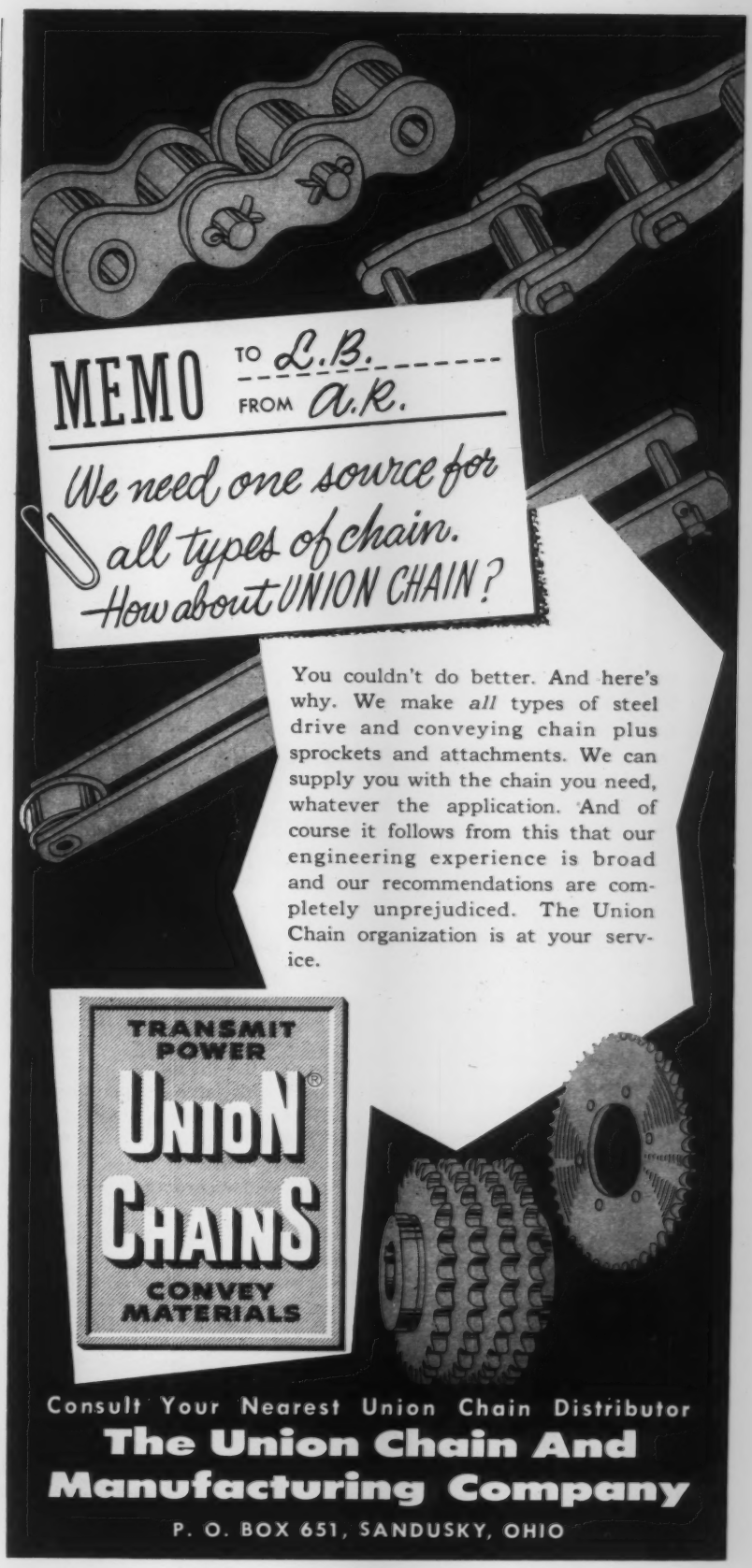
Structural Adhesive

Resiweld adhesive No. 105, a one-component epoxy based structural adhesive that hardens permanently when cured with heat, is detailed in Technical Bulletin RTB-18A. Product resists moisture, water, solvents, and chemicals. Characteristics are in table form. 4 pages. H. B. Fuller Co., 255 Eagle St., St. Paul 2, Minn. J

Circle 657 on Page 19

Fluid Coolers

Revised Catalog S-395 on fluid coolers describes vertical and horizontal air flow models in 23 sizes. These air-cooled heat exchangers are used for lube oil and engine jacket water cooling, for steam and vapor condensing, or process liquid and gas cooling. Equipment capacity and dimension tables and description of basic components and accessories are included. Write on company letterhead to Trane Co., La Crosse, Wis. K


MEMO TO L.B.
FROM A.R.
We need one source for all types of chain. How about UNION CHAIN?
You couldn't do better. And here's why. We make all types of steel drive and conveying chain plus sprockets and attachments. We can supply you with the chain you need, whatever the application. And of course it follows from this that our engineering experience is broad and our recommendations are completely unprejudiced. The Union Chain organization is at your service.
TRANSMIT POWER
UNION CHAINS
CONVEY MATERIALS
Consult Your Nearest Union Chain Distributor
The Union Chain And Manufacturing Company
P. O. BOX 651, SANDUSKY, OHIO

Circle 501 on Page 19

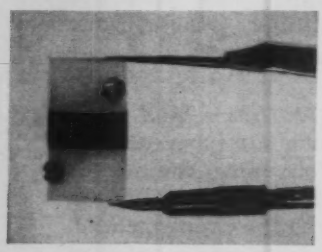
New Parts and Materials

Use Yellow Card, page 19, to obtain more information

Tiny Flexible Coupling

is 0.740 in. long and has OD of 0.4 in.

Gear Grip 5-G flexible coupling, weighing only 1½ grams, is suitable for instrumentation, electronic, radio, business machine, and similar equipment where miniaturization is required. Unit has over-all



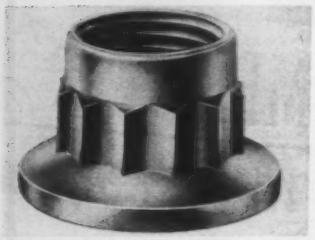
length of 0.740 in. and 0.4 in. OD. Standard shaft sizes are ⅛, 3/16, and ¼ in. End fittings are available with or without 4-40 setscrews. No assembly clearance is required between end fittings and rubber flex-element, eliminating backlash. End fittings are nylon, providing electrical insulation between shafts. Over-all length of unit and composition of rubber flex-element material can be modified to meet requirements. **Guardian Products Corp.**, Dept. 31, 1215 E. Second St., Michigan City, Ind. J

Circle 658 on Page 19

High-Strength Lock Nuts

develop fatigue strength of 220,000-psi bolts

New LH 3393 double-hex, external-wrenching, self-locking nuts are available for advanced design high-tensile bolting requirements. They develop full fatigue strength of 220,000-psi bolts. Nuts provide required performance characteristics of MIL-N-2507 (ASG), yet are from 10 to 33 per cent lighter than 180,000-psi lock nuts of the same



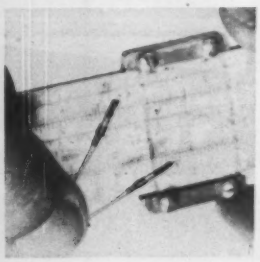
size. Further weight saving is made possible by smaller envelope dimensions. Nuts are presently available in thread sizes No. ¼-28, 5/16-24, ⅜-24, 7/16-20, and ½-20, with larger sizes soon to be available. **Elastic Stop Nut Corp. of America**, 2330 Vauxhall Rd., Union, N. J. D

Circle 659 on Page 19

Temperature Probe

is made from a silicon crystal

Sensistor temperature probe has positive temperature coefficient that results in a constant rate of change of 0.7 per cent per deg C along a retraceable curve. Unit is encased in a glass package only 0.078 in. in diam and 0.5 in. long. Small size, coupled with large temperature coefficient of resistance, enables unit to indicate quickly temperature changes by measuring resistance in a mass and recording it as a temperature indication. Applications include telemetering, liquid fuel temperature measurement, and other military and industrial cir-



cuitry requiring high reliability and performance over wide temperature ranges. Probe is made from a silicon crystal with monocrystalline structure. It is available in standard resistances of 100, 500, and 1000 ohms. **Texas Instruments Inc.**, P. O. Box 312, Dallas, Tex. P

Circle 660 on Page 19

Aluminum Alloy

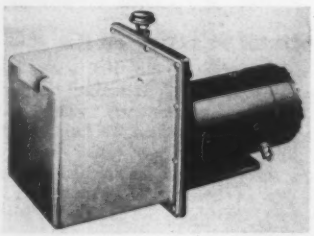
has tensile strength of 48,000 to 50,000 psi

Alloy 357 has high tensile and yield strengths, with high elongations and excellent castability. It develops considerably higher mechanical properties than alloy 356, and handles with the same ease. Properties include tensile strength of 48,000 to 50,000 psi, yield strength, 35,000 to 37,000 psi, and elongation, 6 to 10 per cent. **Reynolds Metals Co.**, Richmond 18, Va. C

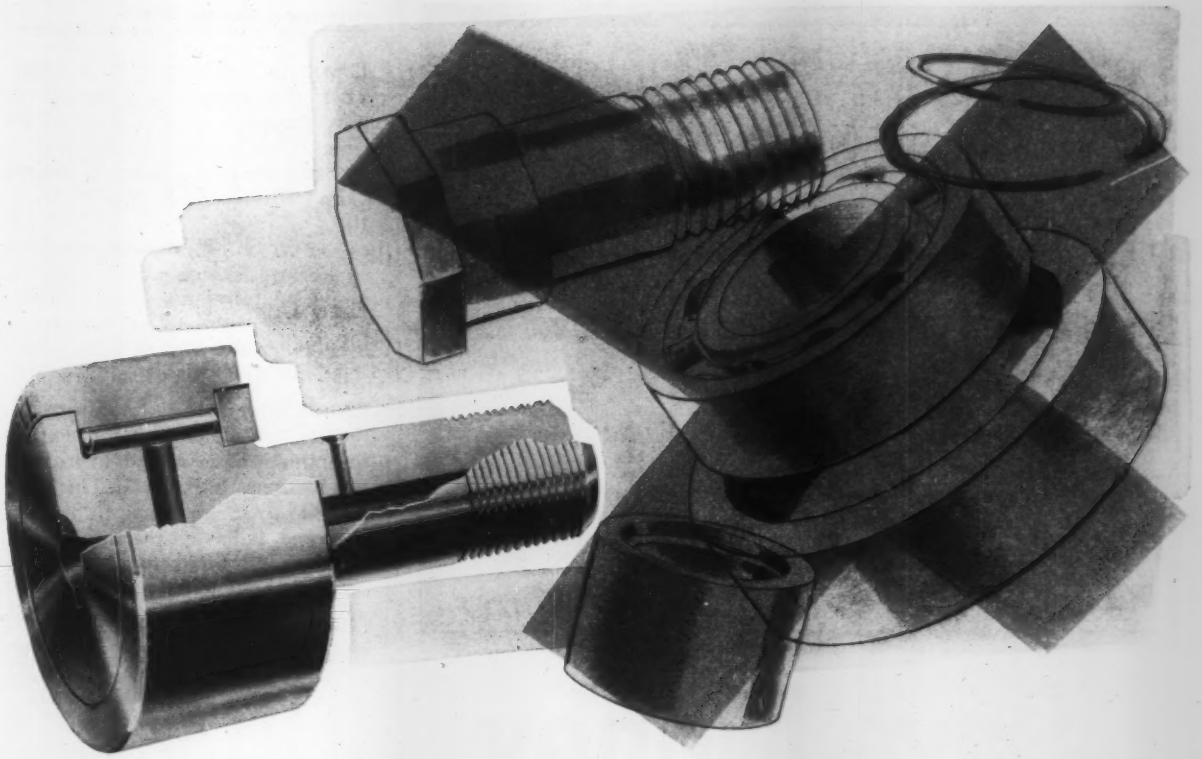
Circle 661 on Page 19

Hydraulic Units

self-contained units provide ½ to 4 gpm



Self-contained hydraulic units are engineered from standard pumps, motors, valves, and reservoirs to provide ½ to 4 gpm at 1800 rpm with pressures to 2000 psi. Pumps are furnished with check valve, relief valve, and/or manual or solenoid-operated lowering valves. Duplex pumps or pumps with built-in unloading valves or special hydraulic features are also available.



McGILL® CF *CAMROL*® bearings

eliminate the cost of producing and assembling improvised cam follower, track and guide roller units

THESE CAMROL ADVANTAGES SOLVE COST, DESIGN, PRODUCTION AND PERFORMANCE PROBLEMS:

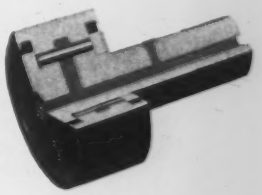
• AVAILABILITY • INTEGRAL UNIT CONSTRUCTION • HIGH LOAD CAPACITY • SMALL RADIAL SPACE REQUIREMENTS • HIGH SHOCK RESISTANCE • PRECISION ACCURACY • SIMPLIFIED LUBRICATION

You can simplify design and cut cost with CAMROL, precision cam followers. Procurement, production and assembly of components for improvised units are eliminated when you specify CAMROL bearings that are available from stock.

McGill developed the original roller bearing cam follower and perfected the CAMROL design through 25 years of application experience. Its full type construction provides exceptionally high capacity in an integral unit of a flanged, specially heat treated stud and heavy shock resistant outer race. Grease lubrication is simplified. Plain bearings require constant oil lubrication and bolt mounted ball bearings races crack under equivalent loads.

Precision construction, including concentricity of stud to outer race OD, provides accurate alignment of machine members. Ease of interchangeability and dependable operation in any cam action, track, guide or support roller application is assured. Use the CYR series in the same roller diameters for shaft mounting.

PRE-LUBRICATED SEALED CAMROL BEARINGS



These bearings combine the advantages of CF and CYR series bearings plus effective sealing against dirt, dust and grit. Ideal in applications where lubrication is a problem. Black ferrous oxide finish resists corrosion in contaminated areas.

CAMROL bearings are available in standard roller diameters from ½" to 4". Capacities to 20480 lbs. at 100 RPM.

WRITE FOR FREE CATALOG NO. 52-A

engineered electrical products

McGILL®

precision needle roller bearings

McGILL MANUFACTURING COMPANY, INC., BEARING DIV., 200 N. LAFAYETTE ST., VALPARAISO, INDIANA

Circle 502 on Page 19

BEFORE...
Separate Bolts, Nuts and Washers complicate inventories, increase assembly costs.
AFTER...
Washers as integral parts of bolts and nuts eliminate problems, speed assembly at lower cost.

Save Money

by simplifying fastener design

Here is a simple application of a basic bolt making principle which is affecting substantial savings for a number of manufacturers.

These savings, resulting from simplified design, are realized in every step of the operation from lower first cost of the fasteners through inventory to final assembly. Totalled, they are well worth while.

There are many other basic principles . . . often overlooked in designing and specifying fasteners, which are of importance cost-wise.

You'll find them in our new booklet, "How to specify fasteners . . . and save". Filled with drawings and charts, it makes a handy guide in designing or buying any headed parts.

If you can use a copy, write to North Tonawanda or ask a Field Representative.

BUFFALO BOLT COMPANY

Division of Buffalo-Eclipse Corporation

North Tonawanda, N. Y. • Princeton, Illinois

MAKING BOTH FASTENERS AND FRIENDS FOR 100 YEARS

● *3 convenient service centers*

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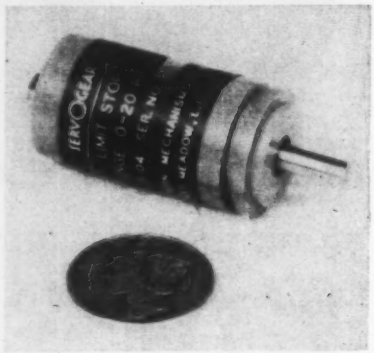
Direct or belt drive is supplied with continuous or intermittent-duty motor. Motor ratings are from ¼ through 2 hp ac, and 6, 12, and 24 v dc. **John S. Barnes Corp.**, 301 S. Water St., Rockford, Ill. K

Circle 662 on Page 19

Limit Stop

subminiature unit is infinitely adjustable

LS 104 subminiature, multiturn, infinitely adjustable limit stop for use in miniature servo and instrument mechanisms is 0.625 in. in diam and 1 7/32 in. long. Synchro mounted, it has torque rating of 18 oz-in. Unit limits rotation to any angle from 0 to 20 revolutions by an external screw. Precision ball



bearings provide low starting torque. Of anodized aluminum alloy and corrosion-resistant steel construction, limit stop meets requirements of MIL-E-5400. **Precision Mechanisms Corp.**, 577 Newbridge Ave., East Meadow, N. Y. D

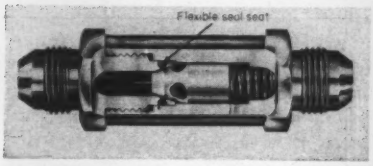
Circle 663 on Page 19

Check Valves

withstand extreme shock and vibration

Improved Kep-O-Seal spring-loaded hydraulic and pneumatic check valves are furnished in six standard Dryseal pipe and JIC tube sizes and 12 connection combinations. They withstand extreme shock, retain positive leak-tightness, have positive action at very low pressure, and full flow with low pressure drop. Freedom from vibration and chatter, long life, and easy maintenance are also provided. Flexible seat design permits handling of dirt and

Circle 503 on Page 19



foreign particles without loss of positive sealing action or damage. Flexible seal closes around foreign particles but cannot be permanently indented. Valves are for use in all hydraulic and pneumatic installations. **Kepner Products Co.**, 7361 W. 59th St., Box 407, Summit, Ill. I

Circle 664 on Page 19

All-Weather Seal

for temperatures from −60 to 325 F

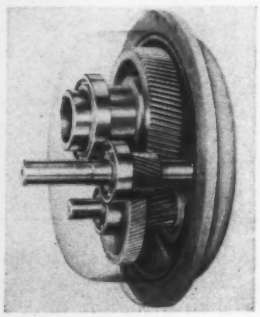
New all-weather seal of Feutron felt material is weatherproof and resists temperatures from −60 to 325 F. The Dacron felt material is nonaging, provides maximum gasketing at low gasket pressures, has very low compression set, and no plastic creep. Weight of the material is 24-26 oz per sq yd, and it is furnished in 72-in. width. Thickness is from 0.165 to 0.210 in. **American Felt Co.**, Glenville, Conn. B

Circle 665 on Page 19

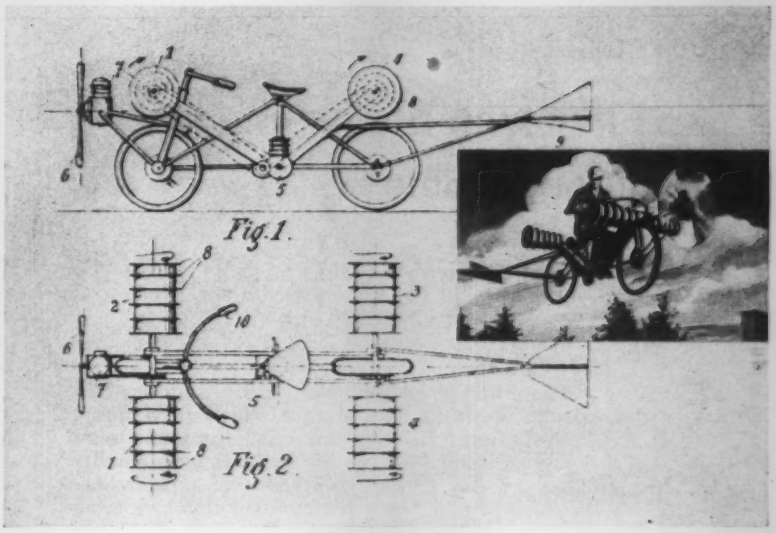
Speed Reducers

shaft-mounted units are single and double-reduction types

New shaft-mounted speed reducers are available in single-reduction drives in six sizes with nominal ratios of 5:1 and capacities up to 50 hp, and in double-reduction drives in seven sizes, with nominal ratios of 15:1 and up to 40 hp. Drives can be mounted at angular as well as horizontal positions by using either tie-rod or foot mountings. Positive



MARS outstanding design **SERIES**

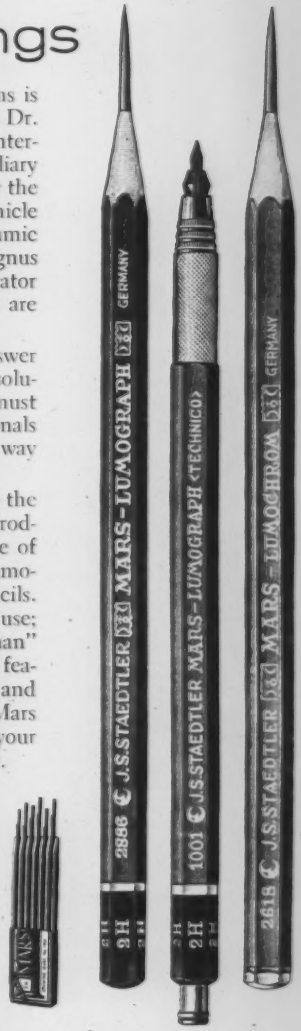


flight without wings

Getting over, rather than around, traffic jams is easy, with this flying motorcycle, says its designer Dr. Manfred Mannheimer, of Newark, N. J. Encountering heavy traffic, it quits the ground. An auxiliary motor rapidly rotates four cylindrical "wings." By the action of the "Magnus effect" these lift the vehicle into the air at 15 mph with 70 hp. The aerodynamic principle involved was discovered by Gustav Magnus in 1858. The cycle's tail-end has a rudder and elevator fin for steering during flight; the rotary wings are telescoped for surface travel.

Whether or not this design will be the answer to traffic congestion, it certainly is an ingenious solution. Aloft or aground, all engineering solutions must originate on the drafting board. And only professionals know how the best in drafting tools smooths the way from dream to practical project.

In pencils, of course, that means Mars, long the standard of professionals. Some outstanding new products have recently been added to the famous line of Mars-Technico push-button holders and leads, Lumograph pencils, and Tradition-Aquarell painting pencils. These include the Mars Pocket-Technico for field use; the efficient Mars lead sharpener and "Draftsman" pencil sharpener with the adjustable point-length feature; Mars Lumochrom, the color-drafting pencils and leads that make color-coding possible; the new Mars Non-Print pencils and leads that "drop out" your notes and sketches when drawings are reproduced.



The 2886 Mars-Lumograph drawing pencil, 19 degrees, EXEXB to 9H. The 1001 Mars-Technico push-button lead holder. 1904 Mars-Lumograph imported leads, 18 degrees, EXB to 9H. Mars-Lumochrom color-drafting pencil, 24 colors.

J.S. STAEDTLER, INC.
HACKENSACK, NEW JERSEY

at all good engineering and drawing material suppliers

Circle 504 on Page 19

versatile

pumping power

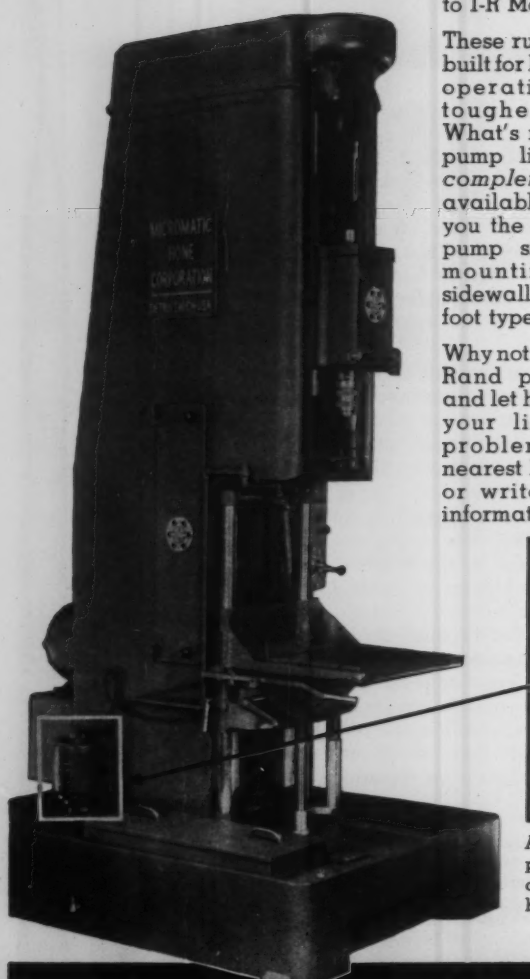
with dependable

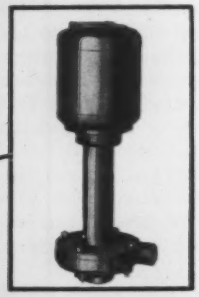
MOTOR PUMPS

The efficient handling of coolant, cutting oils and washing liquids in modern production equipment calls for maximum pumping efficiency. And to solve the various problems in all types of equipment, designers today look *first* to I-R Motorpumps.

These rugged pumps are built for long, trouble-free operation under the toughest conditions. What's more, the Motorpump line is the most *complete* line of pumps available today, offering you the widest choice of pump sizes, types and mountings including sidewall, immersion or foot type.

Why not call an Ingersoll-Rand pump specialist and let him help you with your liquid handling problems. Call your nearest I-R branch office or write for complete information.





An immersion type Motorpump handles abrasive coolant on a modern honing machine.

9-820

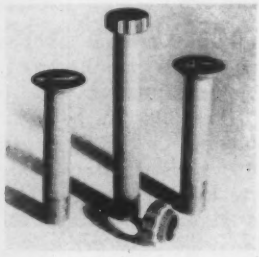
Ingersoll-Rand / 11 Broadway, New York 4, N. Y.

lubrication is assured by oil spray generated automatically through gear rotation, regardless of position in which reducer is mounted. Precision housings and bearing seals keep oil in and dirt out. Units are furnished with key for hollow-shaft sizes and with bushings, complete with key, for driven keyseat to adapt hollow-shaft bore to smaller driven shaft sizes. Photo shows cutaway view of double-reduction unit. **Link-Belt Co.**, Dept. PR, Prudential Plaza, Chicago 1, Ill. J

Circle 666 on Page 19

Shear Fasteners

have minimum shear strength of 156,000 psi



New high-strength aircraft shear bolts and lock nuts are available in twelve series covering four different stress and temperature levels with three different head configurations. Units are 64 per cent stronger than previous standard shear fasteners, and a series for temperature applications to 900 F has 71 per cent greater shear strength at temperature than current fasteners. Included is a new series of aircraft lock nuts with a 12-point external wrenching configuration. Joints have minimum shear strength of 156,000 psi. Standard bolts are heat treated to a tensile strength of 260,000 psi, and 900 F series has minimum rated shear strength at temperature of 120,000 psi. Bolts range in diameter from 1/4 through 5/8 in. **Standard Pressed Steel Co.**, Jenkintown, Pa. C

Circle 667 on Page 19

Light-Duty Ball Bearings

are low-cost units for intermittent operation

New low-cost commercial flanged and radial ball bearings are available for shaft diameters from 29/32

Fabricated
PRECISION
ASSEMBLIES
Formed, Welded
and Machined by
AMWELD®
An important segment of Amweld's subcontract work for the aircraft industry, and more recently for missile use, has been the production of welded precision assemblies. Special skills and techniques have been developed for forming, welding, and machining components . . . particularly those involving aluminum, titanium, stainless and similar heat-resistant alloys.
These special skills and facilities are available for subcontracting or experimental work. If you would like to obtain complete information on the capabilities of American Welding and how we can be of assistance to you — phone or write today. Our local representative will be happy to call and discuss your requirements.
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NEW 20-page catalog of Amweld Rings, Bands, and Welded Assemblies.
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Whatever you make, make it better of aluminum and fasten it with Alcoa® Aluminum Fasteners. Guard against both galvanic and atmospheric corrosion and get lasting sales appeal with bright, carefree aluminum fasteners. For your requirements, call your nearest Alcoa sales office. Complete stocks of all standard types and sizes of Alcoa Aluminum Fasteners are on hand at your local Alcoa distributor. Look in the Yellow Pages of your telephone directory.

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Gentlemen: Please send complete specification data and samples of Alcoa Aluminum Fasteners.

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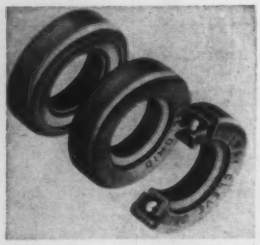
Circle 507 on Page 19



through 2 in. The antifriction units have press-formed, case-hardened inner and outer races, full complement of heat-treated, ground, high-carbon steel balls. Bearings are suited for light-duty, intermittent operation. **Bearing Div., Freeway Washer & Stamping Co.**, P. O. Box 1756, Cleveland 5, Ohio. G

Circle 668 on Page 19

Sandwich Panel Material

provides excellent strength-to-weight ratio

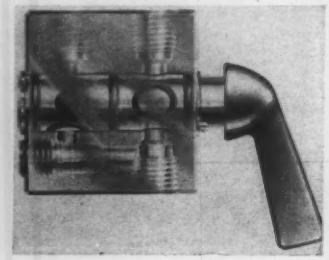
Mortonbond sandwich panel material consists of a core of material such as paper, aluminum honeycomb, or rigid form, bonded to any skin such as steel, stainless steel, or aluminum. Material provides excellent strength-to-weight ratio and extreme flatness. Variety of sizes, including oversize sections, can be fabricated. **Morton Mfg. Co.**, 5125 W. Lake St., Chicago 44, Ill. I

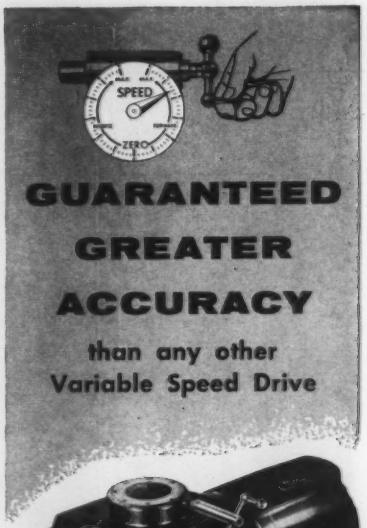
Circle 669 on Page 19

Three-Way Plug Valve

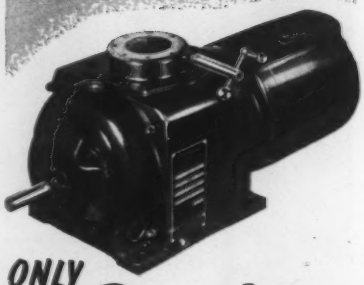
provides minimum pressure drop

Series 9300 three-way plug valve provides leakproof shutoff and prevents external and body leakage. Design also permits valve to provide minimum pressure drop. Use of O-rings on face of a cylindrical plug and on diameter of plug produces easy operation and maintenance-free service life without adjustment. The general-purpose valve





GUARANTEED GREATER ACCURACY than any other Variable Speed Drive



ONLY *Graham*

most reliable variable speed drive made

offers these...

BIG FOUR FEATURES!

1. UNLIMITED SPEED RANGE — from any desired maximum speed to zero, including reverse, without stopping motor.
2. UNMATCHED ACCURACY — of speed setting and re-setting, and of speed holding.
3. ULTIMATE in SIMPLICITY and COMPACTNESS — a straight line extension of a standard induction motor — or available without motor.
4. AUTOMATED SPEED CONTROL — control tension, proportion, synchronization, etc. from any control signal; 3 to 15 PSI, .5 to 5 ma, potentiometer, frequency, or binary signal from punch cards, tapes, or computers.

SEE OUR CATALOG IN SWEET'S PRODUCT DESIGN FILE OR WRITE FOR COPY

All this backed by PROVED PERFORMANCE to do a better job for LESS MONEY!

GRAHAM TRANSMISSIONS, INC.
DEPT. MD, MENOMONEE FALLS, WIS.

Circle 508 on Page 19

for both gas and liquid circuits has three ports arranged to provide one inlet, one outlet, and an exhaust, either piped or atmosphere. When functioning as a selector valve it provides either one inlet and two outlets or two inlets and one outlet. Typical applications include test benches, pilot and process plants, pneumatic and hydraulic equipment, and plant air circuits. Operating temperature range is −40 to 250 F, and operating pressures range from −14.7 to 150 psi. **Circle Seal Products Co.**, 2181 E. Foothill Blvd., Pasadena, Calif. L

Circle 670 on Page 19

Three-Dimensional Cams

withstand shock and vibration

High - precision three - dimensional cams provide an accurate, dependable means of control in the aircraft, rocket, missile, and other related fields. They withstand shock,

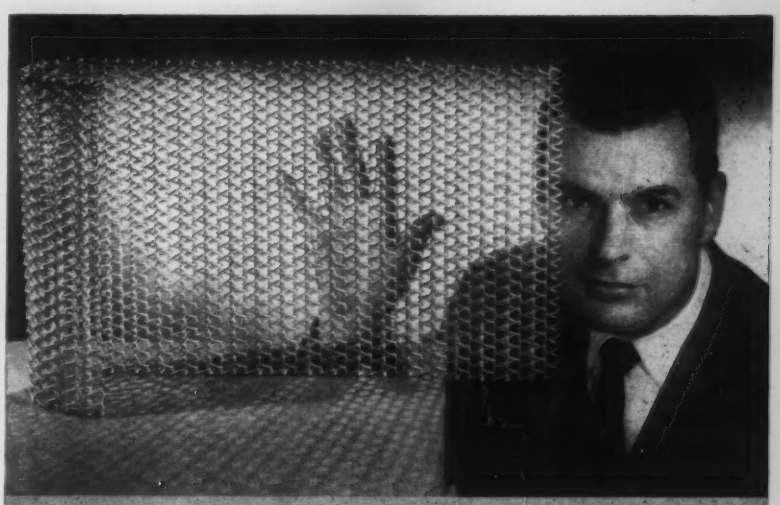
vibration, and other severe environmental conditions. Producing an output motion determined by two input variables, cams provide savings in space and weight. **American Cam Co. Inc.**, P. O. Box 2106, Hartford, Conn. B

Circle 671 on Page 19

Subminiature Switch

incorporates flexible bushing inside phenolic case

Type SS subminiature snap-acting switch is for use in applications where small size, reliability, safety in explosive atmospheres, and sealing against moisture, dust, and splashing liquids are essential. Switch has a flexible bushing compressed around pin actuator inside phenolic case. Case halves are bonded together, making switch moisture, dust, and explosionproof per MIL-E-5272. Unit is furnished



WHAT CAN YOU DO WITH THIS FLEXIBLE, DURABLE METAL-MESH FABRIC?

Metal-mesh fabric—flexible, durable and with open mesh—has been accepted for years as a basic material for the fabrication of woven wire conveyor belts. Recently, though, resourceful design and production men have been finding new uses for this versatile woven wire construction. For example, slings for materials handling, protective curtains for forging operations, containing curtains for heat treating operations, tread reinforcements for modern high speed tanks, and even such domestic articles as doormats, fireplace screens and flexible room dividers.

Here are the important physical characteristics of metal-mesh fabric. How can you use them in your designing or production operations?

FLEXIBILITY—spiraled wire construction gives complete one-direction flexibility. You can coil it, draw it up on itself as a curtain or take it around corners.

OPEN MESH—Mesh size can be varied from 1/64" to 2½" or larger to provide for the passage of air, liquids, light or gases, but retain solid matter or particles.

DURABILITY—this fabric is of all-metal construction and can be produced in any metal or alloy, thus can be made resistant to heat, cold, corrosion, erosion or damage from impact or shock.

VARIETY—metal-mesh fabric can be woven to any length or width and in any of nine basic patterns. Further, any number of special side, surface or end attachments can be fitted to it.

WANT A SAMPLE?

Simply tell us what you have in mind as a possible use for metal-mesh fabric and we'll make up a sample section for your inspection and testing. Our own Field Engineer in your territory will deliver your sample to you personally and discuss your application with you.

Write direct or look under "Wire Cloth" in your classified telephone directory to talk to the Cambridge man nearest you.

The Cambridge Wire Cloth Co.

WIRE CLOTH | METAL-MESH CONVEYOR BELTS | WIRE CLOTH FABRICATIONS

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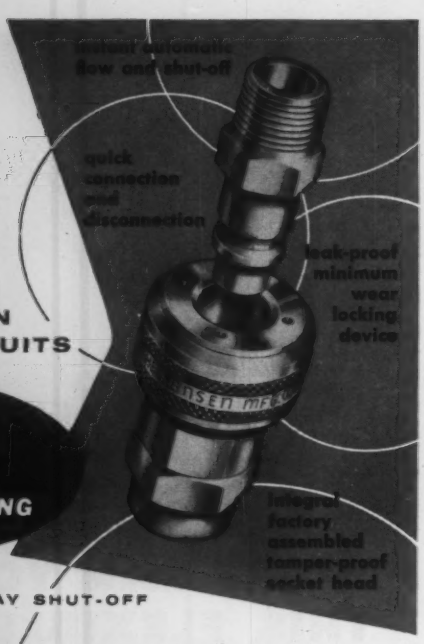
Maryland

OFFICES IN PRINCIPAL INDUSTRIAL CITIES

Circle 509 on Page 19

Thoroughly Proved...

BY YEARS OF HARD EVERYDAY USE ON FLUID LINE CIRCUITS


quick connection and disconnection
leak-proof minimum wear locking device
integral factory assembled tamper-proof socket head

HANSEN
QUICK-CONNECTIVE
PUSH-TITE COUPLING

ONE-WAY SHUT-OFF

Locking pins in Hansen Push-Tite Coupling Socket afford large area contact with Plug, thereby preventing wear and subsequent leakage.

● The ability of Hansen Push-Tite Couplings to withstand severe service—with practically no maintenance—has been thoroughly proved by years of hard, everyday use on hundreds of fluid line circuits. The "socket head", which contains the locking device, is factory assembled into a rugged integral unit which cannot be readily injured or have component parts lost by casual tampering.

To connect the Coupling, you merely push the Plug into the Socket with one hand. Flow is instantaneous. To disconnect, push back sleeve on Socket—Coupling disconnects. Flow is shut off instantly and automatically.

QUICK-CONNECTIVE FLUID LINE COUPLINGS for

AIR
OIL
GREASE
HYDRAULIC FLUIDS
WATER
VACUUM
STEAM
OXYGEN
ACETYLENE
REFRIGERANTS
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★

REPRESENTATIVES IN PRINCIPAL CITIES

WRITE FOR THE HANSEN CATALOG

Here's an always ready reference when you want information on couplings in a hurry. Lists complete range of sizes of Hansen One-Way Shut-Off, Two-Way Shut-Off, and Straight-Through Couplings—including Special Service Couplings for Steam, Oxygen, Acetylene, etc.

REPRESENTATIVES IN PRINCIPAL CITIES
QUICK-CONNECTIVE FLUID LINE COUPLINGS

SINCE 1915

THE HANSEN MANUFACTURING COMPANY

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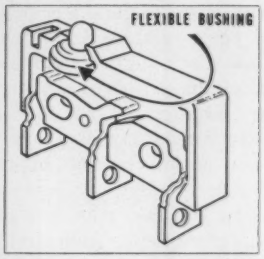


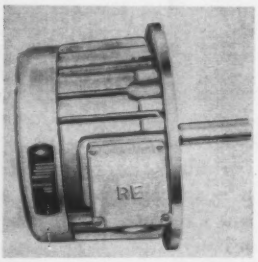
with various actuators, both integral and auxiliary types. Electrical rating is 5 amp 125, 250 v ac, 5 amp 30 v dc resistive, and 2½ amp 30 v dc inductive. **Unimax Switch Div., W. L. Maxson Corp.**, Ives Road, Wallingford, Conn. B

Circle 672 on Page 19

Machine-Tool Motors

have fin-type design

New heavy-duty machine-tool motors have fin-type design which provides excellent heat-dissipation ratio. Rotors are dynamically balanced and mounted between two heavy-duty ball bearings. Radial air-gap design permits use of light, thin, low-inertia rotor which permits smooth starts and quick stops. Motors are available in ratings from ½ to 10 hp in totally enclosed, fan-cooled and totally enclosed,



nonventilated types for continuous or intermittent duty. **Reuland Electric Co.**, 3001 W. Mission Rd., Alhambra, Calif. L

Circle 673 on Page 19

Dry-Bearing Material

for use at temperatures from −400 to 550 F

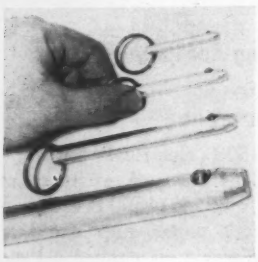
Rulon-S dry-bearing material consists of a steel-backed woven-wire mesh supporting matrix impregnated with a formulation of Rulon and given a surface treatment. Rulon is integrally locked into the wire mesh, providing a wear surface with

excellent bearing properties. Bearings can be run at high loads and speeds because thinness of Rulon layer and presence of wire mesh provide excellent heat dissipation and practically eliminate cold flow. Material is available in flat sheet, rolled-sleeve bearings, and in sheet or strip form in sizes up to 6 x 12 in. Flexible liner portion is also available separately, consisting of wire mesh combined with Rulon on one or both faces. Bearings operate at temperatures from −400 to 550 F. They have been run continuously for over 1000 hr at *PV* values of 20,000, and intermittently at values to 40,000. **Dixon Corp.**, Bristol, R. I. B

Circle 674 on Page 19

Quick-Release Pins

are self-retaining



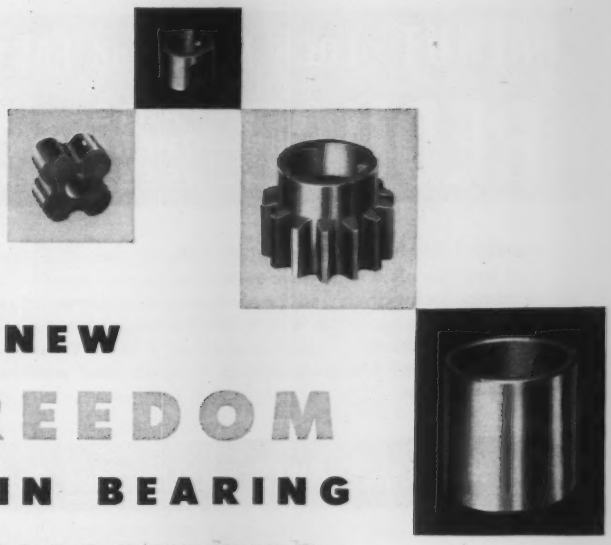
New quick-release, self-retaining detent pins, designated Faspins, meet requirements for fast assembly, disassembly, or quick removal. Standard units are of steel having high shear strength and surface hardness. Pins are available in standard sizes of 1/4 to 1 in. and lengths of 3/10 to 8 in. Wide range of sizes, materials, finishes, and styles meet military and commercial specifications. **Aerofast**, P. O. Box 324, Wheaton, Ill. I

Circle 675 on Page 19

Control Valve

for external pilot supply

Hi-Speed Inline poppet-type, pilot-operated control valve is designed for external pilot supply in brake, clutch, and other high-speed operations where main operating pressure is below 20 psi, where valve is controlling vacuum to 1 in. Hg absolute, or where pressure on valve is reduced below 20 psi for machine setup. Valve has only two moving

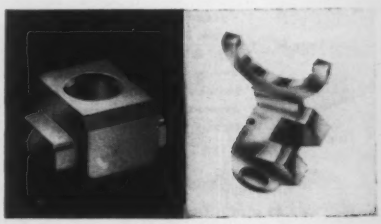


A NEW FREEDOM IN BEARING APPLICATIONS

Availability of Sintered Powdered Metal Bearings and machine parts from a fully competent and technically responsible source opens the way to improvements in mechanical products.

Bunting facilities for designing, engineering and manufacturing of Sintered Powdered Metal Bearings and parts are as comprehensive and responsible as the traditional Bunting competence in the field of Cast Bronze Bearings.

A competent group of Bunting Sales Engineers in the field and a soundly established Product Engineering Department put at your command comprehensive data and facts based on wide experience in the designing and use of Cast Bronze and Sintered Powdered Metal Bearings and parts.



Write for catalogs and your copy of the new 24 page Bunting Engineering handbook of Sintered Powdered products and their composition, manufacture and application.

Bunting®

BUSHINGS, BEARINGS, BARS AND SPECIAL PARTS OF CAST BRONZE AND POWDERED METAL

The Bunting Brass and Bronze Company • Toledo 1, Ohio • Branches in Principal Cities

Circle 511 on Page 19

PALNUT® LOCK NUTS and FASTENERS REDUCE — PARTS — OPERATIONS — ASSEMBLY COSTS

PALNUT Lock Nuts are precision-made of tempered spring steel—cost less than plain nuts—save 65-85% in fastener weight—save space—eliminate lockwashers and flat washers—assemble easily and fast with standard tools, extra-fast with PALNUT Magnetized wrenches—hold tight under vibration. Other specialized PALNUT Fasteners provide big savings and better assemblies on unthreaded studs, rods, rivets, pins and shafts.

PALNUT LOCK NUTS for Threaded Assemblies

Regular Type. Used alone as a load-carrying nut on light duty assemblies or used on top of ordinary nuts on high stress assemblies.

Washer Type. Lock nut and washer in one piece, replaces ordinary nut, lock washer and flat washer. Many design variations.

Inverted Type. A compact lock nut for light duty assemblies. Pleasing round dome.

Wing Type. Combines locking principle of PALNUTS with ease of finger tightening and removal.

Acorn Type C. Smooth dome shape covers up unsightly, rough bolt ends for attractiveness and protection against scratching.

Acorn Type CK. Semi-acorn type, used as a lock nut when seated—or as an adjusting nut or stop nut anywhere on threads.

Tension Nuts. Hold adjusting screws to desired setting. Easy assembly—simple adjustment.

Self-Retaining Nut. Spring-tempered steel captive lock nut for #8-32 screws in blind applications. Flared sides retain nut in slots or cavities.

FASTENERS for Unthreaded Studs, Rods, Pins, etc.

Washer Base

Regular Hex

SELF-THREADING NUTS

Form their own deep, clean threads while tightening on unthreaded zinc die-cast studs; also on unthreaded rod or wire of steel, aluminum or brass. Save threading costs. Fast assembly with standard tools. Provide vibration-proof grip, whether seated for load-carrying or unseated as a "stop nut". Remove and re-use on same studs. Sizes for 1/4", 5/16" and 1/4" dia.

Cap Type W

Flat Type H

PUSHNUT® FASTENERS

Simply push or tap on unthreaded studs, rod, wire or rivets. Save threading, notching, drilling for cotter pins. Strong spring grip resists removal. Low in cost, fast assembly. Many types and sizes

Acorn Type C closed end

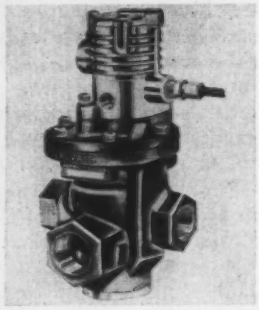
Acorn Type CK open end

Write for Catalog 573-C and Free Samples, stating type, size and application.

THE PALNUT COMPANY, 75 Glen Road, Mountainside, N. J.
In Canada: P. L. Robertson Co., Ltd., Milton, Ont.

PALNUT® LOCK NUTS FASTENERS PAL®

Quick, secure fastening at low cost



parts, and poppet is completely air-cushioned. Unit is available in two and three-way types, normally open or normally closed, in sizes from 1/4 to 1 1/2 in. NPT and for working pressures from vacuum to 1 in. Hg absolute to 20 psi. Solenoid-pilot coils for ac or dc, of any voltage, are furnished. **Valvair Corp.**, 454 Morgan Ave., Akron 11, Ohio. F

Circle 676 on Page 19

Potting Compound

for use at temperatures to 1500 F

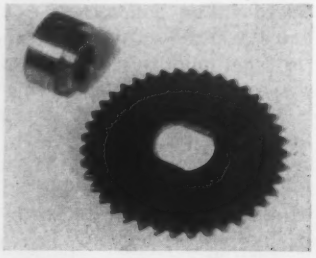
No. 1500 electrical potting compound is for use at temperatures from −65 to 1500 F. It adheres to metal, paper, and wood, but is not adhesive to rubber. Practically inert and nontoxic, compound is not sensitive to thermal shock when cured. **Orell Inc.**, Box 527, South Gate, Calif. L

Circle 677 on Page 19

Stamped Sprockets

for roller chains

New die-cut sprockets for roller chains are furnished with or without shouldered hubs from 11 to 80 teeth, in various roller-chain sizes. Plate-type sprockets are furnished with a flattened hole to receive flattened shoulder hubs. They can also be provided with plain round holes, either in plain 1020 steel or



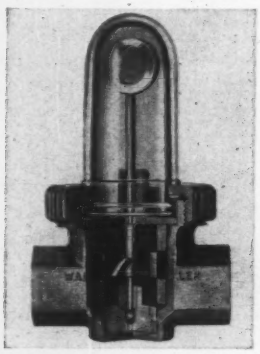
case hardened to requirement. Dayton Rogers Mfg. Co., 2824 13th Ave. So., Minneapolis, Minn. J

Circle 678 on Page 19

Flow Indicator

for flows from 0.72 to 24 gpm

Arkon flow indicator consists of a chromium-plated ring spinning under a toughened glass dome. If spinning stops, liquid is not flowing. Indicator can be reset in the field for high or low range. It is



available with die-cast brass body in ½, ¾, and 1-in. pipe sizes for flows from 0.72 to 24 gpm. Walker Crosweller Div., McIntosh Equipment Corp., 15 Park Row, New York 38, N. Y. D

Circle 679 on Page 19

Miniature Speed Changers

are available in over 400 ratios

Series 8 miniature speed changers are for use in cameras, servomechanisms, oscillographs, chart drives, and other units. Black anodized aluminum cases have size 11 servo mounts, with several other types of attachable mounts also available. Input and output shafts run in double heavy-duty ball bearings. Countershafts run in self-lubricated sintered-iron and copper bearings. Precisely hobbed, smooth-running spur gears are 96 pitch and 20-deg pressure angle. Ratios from 1:1 to 5:1 handle up to 16 oz-in. of torque; ratios from 6:1 to 5314441:1 handle up to 24 oz-in. torque, measured at low-speed shaft. Speeds to 10,000 rpm at high-speed shaft are reached without excessive wear. Maximum power output at low-speed shaft is

NEW

FROM U.S. GAUGE

SUPERTHERM dial thermometers

Engineered . . . to equal the premium quality and dependable performance of superior USG Grade AA Supergauge pressure gauges.

Priced . . . at a money-saving value that's news in itself.

Designed . . . in a range of styles and sizes to serve any plant in any industry with the *most comprehensive line of indicating thermometers available from one source today!*

NOW all your requirements for standard, filled system dial thermometers met with one top grade line that features all these specifications. See your USG distributor, or write for Catalog 205.

DIRECT READING—rigid, direct mounting; or "Multi-Angle" type

REMOTE READING—for temperature measurement up to 125 feet from indicator

4 TYPES OF FILLS—organic liquid, gas, vapor, mercury

ALL COMPENSATIONS—complete selection of case or capillary compensation available as required

29 STANDARD RANGES—covering temperatures from −350° to +1000°F

2 CASE MATERIALS—anodized aluminum or phenolic plastic

4 CASE SIZES—3½", 4½", 6" and 8½"

3 CASE STYLES—turret, front flange, or back flange mounting, with choice of bezel

FULL SELECTION OF BULBS—virtually endless combinations of bulb sizes, shapes, materials, and connections.

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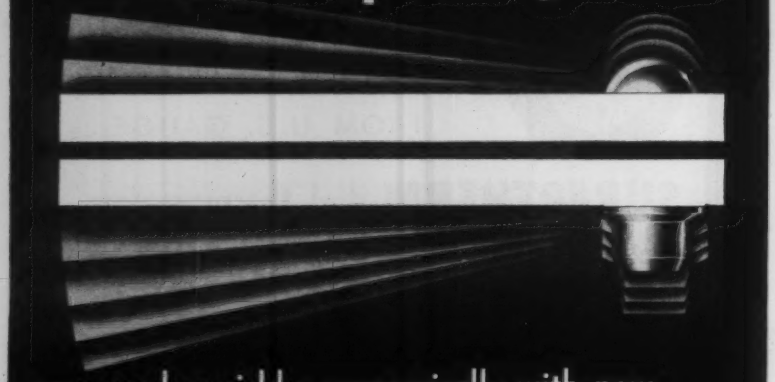
UNITED STATES GAUGE

Division of American Machine and Metals, Inc. • Sellersville, Pa.

USG

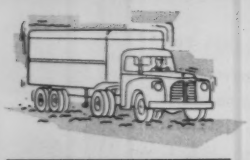
Circle 513 on Page 19

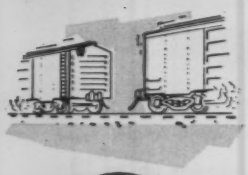
Vibration-proof joints



now made quickly, economically with new

TOWNSEND VERSA-LOCKBOLT





With the new Townsend Versa-Lockbolt* you get the same high tensile values as with the standard type but they cost less and are easier to install.

Wider grip ranges in a given size are provided by additional locking grooves. Other design changes make it feasible to use them in relatively oversized holes. Inspection time is reduced since hole size is less critical.

These features make for flexibility of design—make calculations simpler and more accurate.

Versa-Lockbolt installation is fast and guns provide uniform draw down or clinch —locking the collar with up to five tons of pressure. The new collar with its flanged integral washer makes it especially suitable for fastening even light gage materials.

For more information on how to get new vibration-proof fastening economy, write Townsend Company, P.O. Box 237-E, New Brighton, Pa.

*Licensed under Huck patents RE 22,792; 2,114,493; 2,527,307 2,531,048; 2,531,049 and 2,754,703

The Fastening Authority

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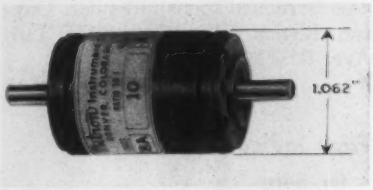


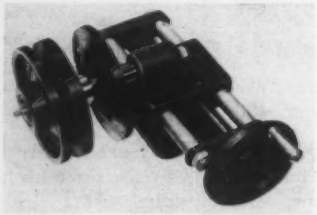
0.025 hp. **Metron Instrument Co.**, 432 Lincoln St., Denver 3, Colo. K

Circle 680 on Page 19

Variable-Speed Pulley

for fractional to 1 hp with ratios to 7.2:1

High Ratio variable-speed pulley mounted on an adjustable control base permits a wide range of speeds to be obtained from almost any ½ or 1-hp constant-speed motor. Pulley is a double variable-pitch unit which automatically adjusts driver and driven-sheave belt speeds according to its distance from driver. Fractional to ½-hp unit has a ratio of 6:1 with pitch diam from 1.875 to 4.6 in. Fractional to 1-hp unit has 7.2:1 ratio with pitch diam from 2.40 to 6.50 in. Faces of pulley are plastic with special additives, providing long life, economical replacement, and minimum maintenance. Pulley assembly is needle-bearing mounted on hardened and ground countershaft, and



simple handwheel adjustment gives precise settings on control base. **Lovejoy Flexible Coupling Co.**, 4932-H W. Lake St., Chicago 44, Ill. J

Circle 681 on Page 19

Hydraulic Fluid

can also be used as lubricant base

New QF-6-7009 alkyl silane fluid can be used as a hydraulic fluid in systems subjected to temperature and environmental extremes. Material is thermally stable in closed systems over range of −25 to 550

Circle 514 on Page 19

TIGHT SHUTOFF AT 1500 PSI...

WITH ASCO'S 2-WAY HIGH PRESSURE SOLENOID VALVES

The ASCO Bulletin 8223 solenoid valve is a heavy-duty type designed for tight shutoff at high pressures. It is especially suited to hydraulic applications, such as hydraulic lifts and elevators — and missile launching platforms.

Features:

- **Operates in any position**
- **Operating Characteristics:** Pressures to 1500 PSI. Temperatures to 200°F. Pipe Sizes—½" to ¾".
- **Low Power Consumption:** Continuous Duty Coils rated 10 watts D-C; 10.5 watts A-C.
- **Standard, Watertight or Explosion Proof Solenoid Enclosures:** May be rotated 360° for easy installation.
- **Large flow capacity:** Valve will handle air, gas, water, light oil and other non-corrosive fluids. Available normally closed, valve features teflon disc and stainless steel magnetic parts.

For Pressures to 3000 PSI: Modified designs are available, suitable for handling nitrogen, hydrogen and oxygen at temperatures to minus 350°F. Furnished in ¼" to 1" sizes, valves can be supplied with explosion proof solenoids, and may be designed for operation on 24 volts D-C or other voltages as required.

These all stainless steel valves are especially suited for use on missile ground support equipment.

New! Catalog No. 202 covers the ASCO line of Solenoid Valves. Write for your copy today.

For Immediate Delivery . . .

World's largest stock of Solenoid Valves. A complete Solenoid Valve Stock List will be sent to you with your copy of Catalog No. 202.

Automatic Switch Co.

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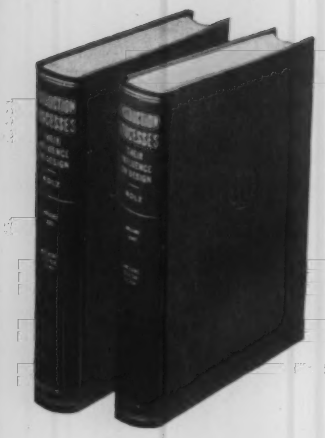
AUTOMATIC TRANSFER SWITCHES • SOLENOID VALVES • ELECTROMAGNETIC CONTROL

ASCO®

Circle 523 on Page 19

how to design for LOW COST production



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COMPANY _____
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CITY _____ ZONE _____ STATE _____

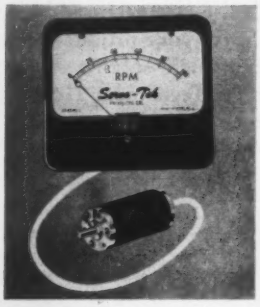
F for long periods and up to 700 F for short times. In addition to use as a hydraulic fluid, material can be used as a base oil in high-temperature turbine lubricants. **Dow Corning Corp.**, Midland, Mich. H

Circle 682 on Page 19

Speed-Indicating System

for speeds from 100 to 12,000 rpm

New speed-indicating system combines a dc tachometer generator with a 4½-in. panel-mounted meter to give full-scale speed indica-



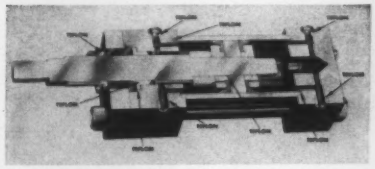
tions from 100 to 12,000 rpm. Generator and indicator are connected by a low-voltage cable up to 500 ft long. Use of a permanent-magnet generator eliminates need for batteries, external power, or periodic calibration. **Servo-Tek Products Co.**, 1086 Goffle Rd., Hawthorne, N. J. D

Circle 683 on Page 19

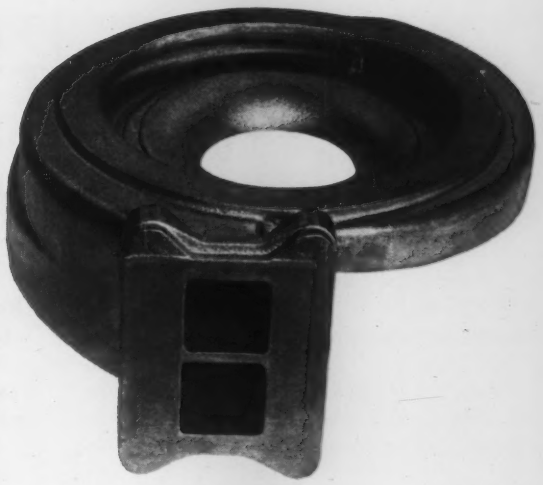
Hydraulic Cylinders

use Teflon for sealing against external leakage

New hydraulic cylinders use Teflon for all sealing against external leakage, and Teflon is also used on rod seals and piston rod. Teflon-sealed cylinders are available for use with noninflammable fluids as a precaution against fire hazard. Cylinders are recommended for use on all types of machines and equipment where elevated temperatures are generated. Rod seals that seal



(*Please turn to Page* 182)



THERMAL SHOCK

A CASE IN POINT—This 20 pound Ni-Resist casting made for the Schwitzer Corporation by Hamilton Foundry is the turbine casing of a diesel engine turbocharger. Exhaust gases which turn the impeller at speeds up to 90,000 rpm subject the housing to rapid cyclic temperature changes up to 1500° F. Any free scale formed at these temperatures could erode and eventually destroy the impeller blades. Ni-Resist was chosen for this part because it produces practically no free scale, it resists growth and oxidation at high temperatures, and it resists cracking under thermal shock.

Ni-Resist iron combines three particular product engineering and design advantages. It resists oxidation: as low as .002 inches per year oxide penetration at 1400° F. Scale formed adheres to the base metal and reduces further oxidation to a minimum. It has high temperature strength: up to 12,000 psi at 1500° F. And it's the toughest of all flake graphite irons: Charpy impact strengths (unnotched) up to 150 ft.-lbs. Hamilton Foundry casts all types of Ni-Resist including Ductile Ni-Resist.

When new and unusual design problems arise in the selection of metal and the casting of parts, you will find that the skill and integrity of your foundry is your best insurance that specifications—and delivery schedules—will be met.

GRAY IRON • ALLOYED IRON • MEEHANITE® • DUCTILE (NODULAR) IRON • NI-RESIST • DUCTILE NI-RESIST • NI-HARD

HAMILTON FOUNDRY

The Hamilton Foundry & Machine Co., 1551 Lincoln Ave., Hamilton, Ohio • TW 5-7491

Circle 515 on Page 19

Republic ELECTRUNITE Mechanical Tubing

...facilities and abilities save production time, materials, costs!

This story is a typical example of how Republic's ELECTRUNITE® Mechanical Tubing—in rounds, squares, rectangles, can work for you.

Syncro Corporation, Oxford, Michigan, manufactures quality jig saws for home workshops. Previously, they used a casting for the blade-yoke which requires a severe bend. ELECTRUNITE Square Tubing was recommended for one model, rectangular tubing for the other.

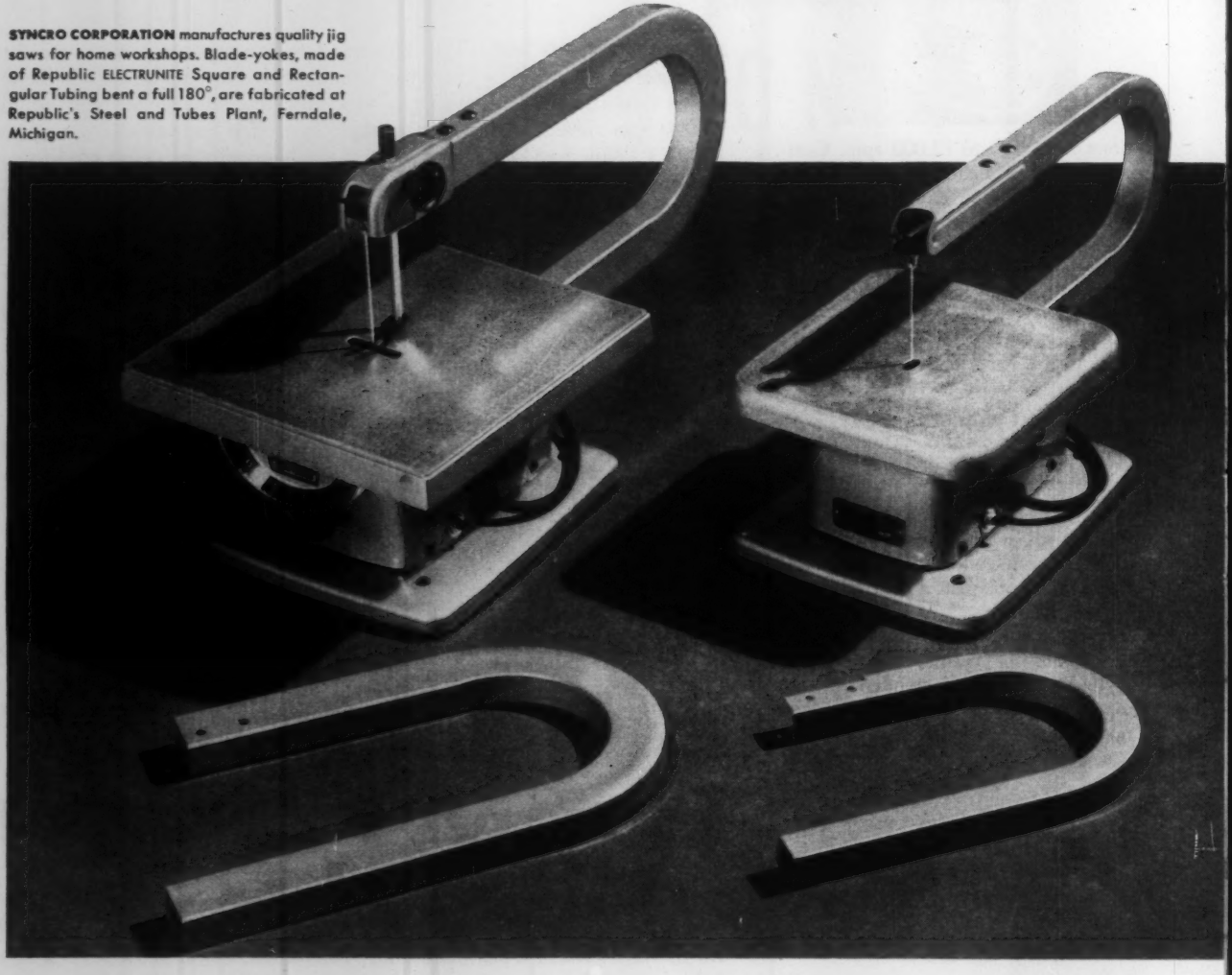
Results: Reduction of weight of the blade-yoke and improvement in the appearance of the product, at a savings in time, materials, assembly, and shipping costs.

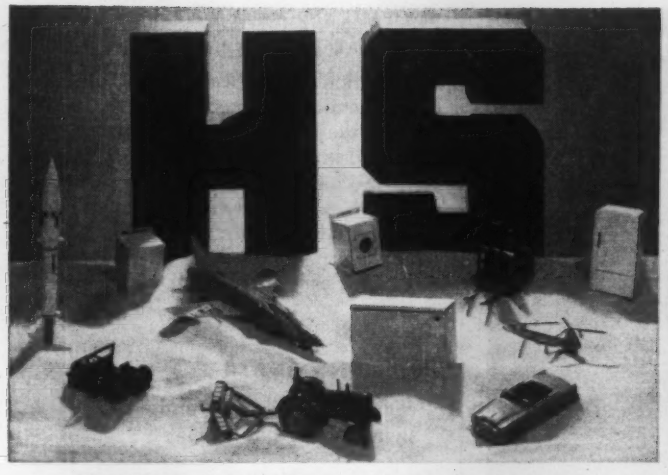
ELECTRUNITE solved this problem because Republic Mechanical Tubing is produced with the ability to withstand severe bending. In both models, ELECTRUNITE Mechanical Tubing is bent a full 180° without noticeable distortion or loss of strength.

Republic's Steel and Tubes Division has the facilities, equipment, and "know-how" to fabricate all grades and types of ELECTRUNITE carbon and stainless tubing into whatever shapes your product requires.

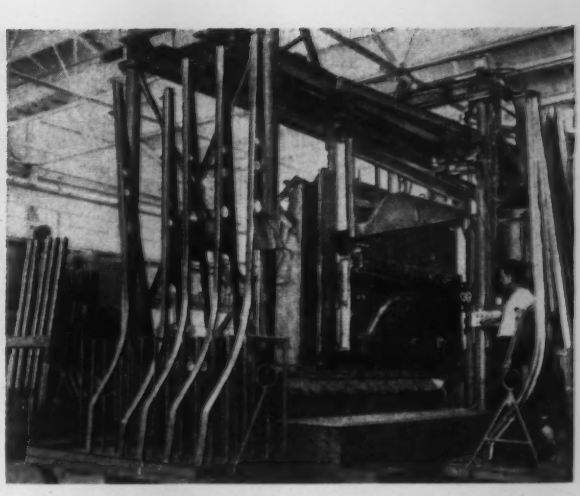
Learn more about the problem-solving advantages of Republic ELECTRUNITE Mechanical Tubing. Call your Republic representative, or write direct.

SYNCRO CORPORATION manufactures quality jig saws for home workshops. Blade-yokes, made of Republic ELECTRUNITE Square and Rectangular Tubing bent a full 180°, are fabricated at Republic's Steel and Tubes Plant, Ferndale, Michigan.





REPUBLIC'S NEW HIGH STRENGTH POWDER, TYPE 6460, opens the way to new markets for new applications using sintering for highly stressed parts. Type 6460 can be used with existing operating equipment. It provides a minimum tensile strength of 60,000 psi at 6.4 density as sintered, 100,000 psi heat treated. Type 6460 maintains its dimensional characteristics after sintering—less than .004 inches per inch shrinkage from die size at 6.4 density. Available in production quantities up to and including 12 tons, or in multiples thereof. Mail coupon for data.



REPUBLIC ALLOY STEEL SOLVES STRENGTH/WEIGHT PROBLEM. Rohr Aircraft Corporation, Chula Vista, California, is currently manufacturing flap tracks for an Air Force bomber fabricated from AMS 6428 Alloy Steel, with minimum tensile strength of 180,000 psi in the heat treated condition. Uniform response to heat treatment assures exceptionally deep hardening characteristics. Exceptionally high strength-to-weight ratio combined with highest strength values permits the design of thinner, lighter track sections. Save weight, hold down size without sacrifice of strength or safety. Send coupon for data.

THERE IS SATISFACTION in knowing that when you specify Republic Fasteners, you can count on consistent uniformity from one unit to the next, year in and year out. You get unswerving quality and dependability in each fastener, in any quantity. Skilled workmen, using modern production equipment like the nut former shown at right, maintain uniform quality in each type of fastener. Your Republic Bolt and Nut Division representative or distributor will be glad to work with you to make sure you get exactly the right fastener to suit your application. Send coupon for full information on types and sizes.

REPUBLIC STEEL

World's Widest Range of Standard Steels and Steel Products

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Please send additional information on the following:

- ☐ Republic ELECTRUNITE Mechanical Tubing
- ☐ Republic High Strength Powder, Type 6460
- ☐ Republic Alloy Steel
- ☐ Bolts and Nuts
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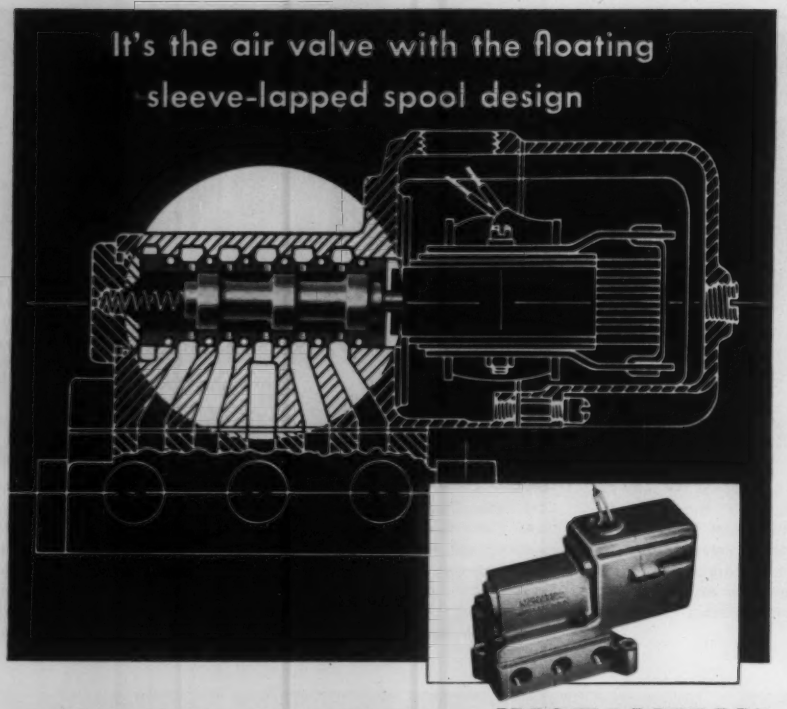
Circle 516 on Page 19



Starts every time—INSTANTLY!

no sticking, lubrication or dirt problems

Familiar with those Monday morning epidemics of sticking valves? Never happens with Numatics air valves . . . not even after *months* of idleness. Because the patented floating sleeve-lapped spool design eliminates the major cause of sticking . . . moving elastic seals. Sealing is accomplished, instead, by the precision finish and close tolerance between spool and sleeve.

And no-stick, no-leak sealing is just one advantage of Numatics valves. Lubrication is no problem, for a Numatics valve is impervious to oil additives. They'll operate on *any* standard lubricant . . . or, they'll run dry if the application requires it. Dirt is no problem, either, because the file hard, razor sharp spool lands and orifice edges chop dirt particles to a fineness that permits passage through the valve without the slightest damage. What's it all add up to? . . . a valve that's more *reliable* and trouble-free, a valve that will last longer than any air valve now available. For complete details send for your copy of catalog #158.

NUMATICS leads the way in manifolds too

For greater efficiency, lower cost, streamline your valve installations with Numatics multiple mount manifolds. Three types available . . . individual or common exhaust and conduit . . . in 2 to 6 stations, 4 pipe sizes. SA Valves mount interchangeably, too!

NUMATICS, Inc. HIGHLAND, MICHIGAN

SALES REPRESENTATIVES FROM COAST TO COAST

(*Continued from Page* 179)

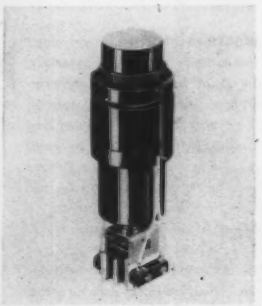
with Teflon do not leak oil, barring heat, chemical, or mechanical damage to seal. Piston rods are case hardened and chrome plated to prevent mechanical damage and are equipped with Teflon dirt wipers. **Miller Fluid Power Div., Flick-Reedy Corp.**, 2040 N. Hawthorne Ave., Melrose Park, Ill. J

Circle 684 on Page 19

Pushbutton Switch

combines indicating and switching in one unit

Tri-Lite pushbutton switch for either flush - panel (shown) or sub-panel mounting can combine monitoring and switching in one compact unit. It monitors three different conditions through a three-color indicator-light assembly. Alter-



nate action "push-push" or momentary "positive feel" are controlled through a pushbutton actuator yoke to the switching assembly. Filter at top of unit has three equally spaced color areas, with 35 standard colors available in various combinations. Lamp circuit can be wired independently or through switching unit. Illumination of each individual lamp passes through precision colored filter and is projected evenly on target screen. High light intensity is provided for standard ambient room lighting. Contact arrangement is double pole, double throw. **Switch Div., Electrosnap Corp.**, 4230 W. Lake St., Chicago 24, Ill. J

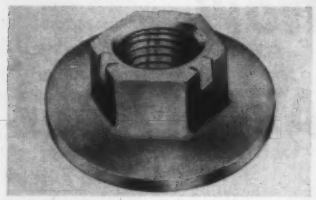
Circle 685 on Page 19

Washer-Base Lock Nuts

lock at any location on a screw or bolt

New one-piece, hexagon washer-base nuts, called Lokuts, are easy

starting and lock at any location on a screw or bolt. They eliminate the need for a separate flat washer,



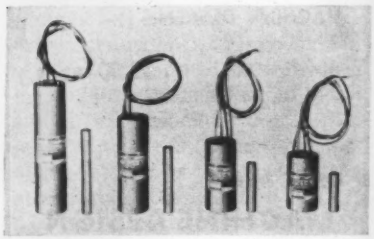
and are available in sizes of No. 10 through ½ in. Nuts are recommended for shock mountings, for retaining spring coils, or for other applications where an object must be held in a fixed position under tension. **Shakeproof Div., Illinois Tool Works**, St. Charles Road, Elgin, Ill. J

Circle 686 on Page 19

Differential Transformer

single-direction unit has doubled range

Series ES-L single-ended, linear variable differential transformer has null position at the end rather than the middle of core travel, with full linear range. New construction makes possible a single-ended range approximately twice that of a conventional transformer of similar



size. Transformer has nominal frequency range of 60 to 10,000 cps and ambient temperature range of −65 to 200 F. **Schaevitz Engineering**, Route 130 & Schaevitz Boulevard, Pennsauken, N. J. D

Circle 687 on Page 19

Vertical Gearmotors

are rated 3 to 30 hp at 25 to 280 rpm

New vertical Syncrogear motors provide internally geared power for industrial agitator applications such as the processing of pigments, chemicals, foodstuffs, pharmaceuticals, and clays. Gearmotors are rated

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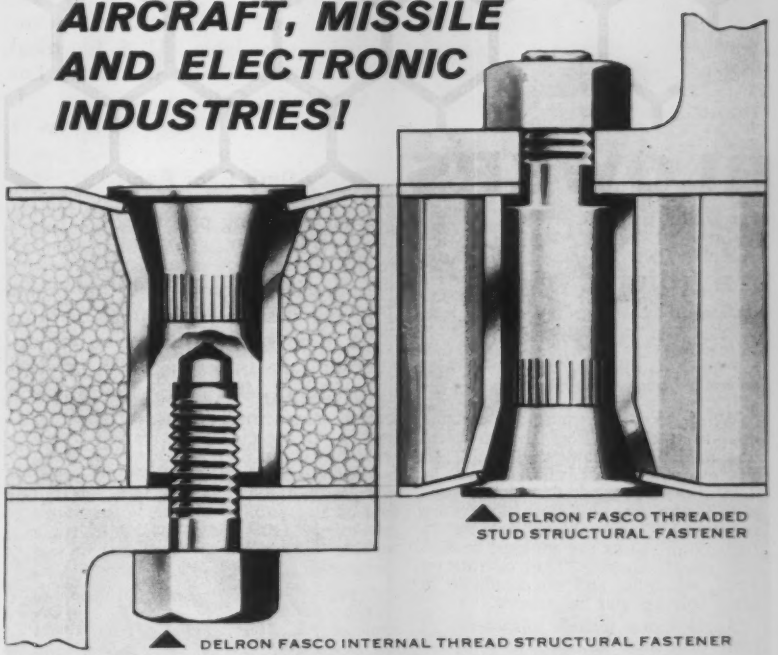

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DELRON FASCO INTERNAL THREAD STRUCTURAL FASTENER

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Circle 518 on Page 19

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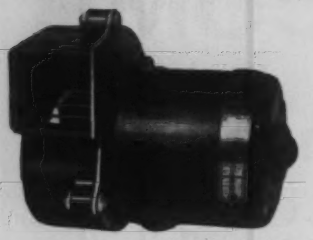
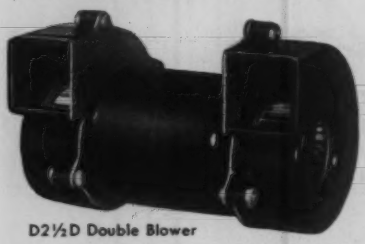


D2½S Single Blower

HEINZE



D2½D Double Blower

BLOWERS

are quiet

When you want quiet, dependable operation, choose from the complete line of Heinze Blowers. The D2½S single unit delivers 17 cfm (free air) at 3100 rpm; D2½D double blower supplies 34 cfm (free air). Both blowers are powered by 2 pole shaded pole induction motor. Units are enclosed in durable plastic housing. They operate on 115V, 60 cycle, and are available in other voltages and frequencies.

Applications include dispersion of heat generated by electronic equipment, induction heaters, diathermy equipment, instrument cabinets, transmitter cubicles, also for tube cooling in television cameras, vending machines and drying operations.

Send coupon for technical data on the complete line of Heinze Sub-Fractional Horsepower Motors and Blowers.

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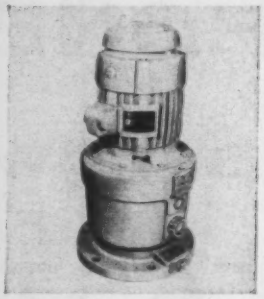


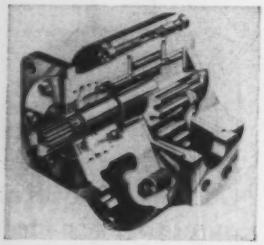
to 30 hp at 25 to 280 rpm. They incorporate an oil circulation window, dry-well construction, centrally located service points, precision gears, single-unit cast-iron housing, and asbestos-protected windings. Uniclosed, totally enclosed, and explosionproof enclosures are available. U. S. Electrical Motors Inc., P. O. Box 2058, Los Angeles 54, Calif. L

Circle 688 on Page 19

Heavy-Duty Gear Pump

for operating pressures to 1500 psi

Improved gear-type fluid-power pump, designated 3000 K, is rated 24 to 65 gpm at 1200 rpm, for operating pressures to 1500 psi and speeds to 2400 rpm. Pump has a two-stage, high-pressure shaft seal and new heavy-duty roller bearings. It is available with either standard SAE flange and shaft, or



with industrial foot mountings. Ports are machined for SAE split-flange connections. Hydreco Div., New York Air Brake Co., Kalamazoo, Mich. H

Circle 689 on Page 19

Bright-Dip Coatings

for copper and brass

Two new coatings in powder form are available for bright-dipping copper and brass. Kenvert 30-C is designed primarily for copper but can

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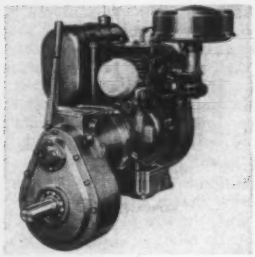
also be used for brass. It is also suited for neutralizing copper-plated parts before subsequent plate, and works on cyanide or acid-plated copper surfaces. Kenvert 30-B, designed primarily for brass, can also be used for copper. It is an excellent base for lacquer. Conversion Chemical Corp., Rockville, Conn. B

Circle 690 on Page 19

Air-Cooled Engine

has combination clutch-reduction unit

Model K331CR air-cooled, short-stroke, four-cycle engine, rated 12.5 hp at 3200 rpm, is designed for applications requiring heavy starting loads and low power takeoff speeds.



It is equipped with a clutch-reduction assembly which combines a dry-type clutch, equipped with anti-friction ball bearings, and a chain-driven reduction gear. Power takeoff shaft is mounted on roller bearings. Unit is available in 2:1, 3.25:1, and 3.79:1 reduction ratios. Starting equipment is either conventional rope starter or 12-v starter-generator. Kohler Co., Kohler, Wis. K

Circle 691 on Page 19

Centrifugal-Action Filter

for compressed-air operated equipment

Model 5704 Whirl-Flo Filterator provides positive protection for compressed-air-operated equipment against oil, rust, dust, and other contaminating particles as small as 5 mu. Louvered baffle plate causes air to whirl as it enters, centrifugally forcing heavier moisture and sludge to walls of unit where they drain into large sump chamber at bottom without touching replaceable textile filter cartridge. Relatively dry, clean air then moves through cartridge where micronic

Fastener Facts

by Dudley H. Campbell, Director of Engineering—Judson L. Thomson Mfg. Co.

FASTENING WITH DEEP-DRILLED RIVETS

When to specify:

You specify deep-drilled rivets (sometimes called tubular rivets), when you want low-cost, permanent fasteners for leather, plastics, rubber, wood, canvas and other easily-pierced, compressible materials.

Millions of Thomson Deep-Drilled Rivets are used each year by leading manufacturers of leather goods, luggage, shoe skates, baseball shoes, camera cases, hand bags, golf bags, and other sporting goods. These self-piercing rivets are used to replace or reinforce stitching.

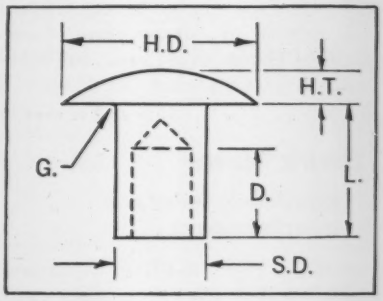
How you benefit:

With Thomson Deep-Drilled Rivets, you can eliminate the cost of pre-punching or pre-drilling holes in materials. Drilled to a depth up to ½" they punch their own holes through the material and compress it within their hollow shanks. Clinched by high-speed automatic rivet-setting machines, which can be operated by unskilled help, they keep assembly time and costs at a minimum.

What dimensions:

Hole Depth (D) of standard deep-drilled rivets always exceeds shank diameter, but never exceeds ½". Exact depth is determined by the compressibility of materials to be fastened and by the clinch requirements of the application. A rule of thumb is to add shank diameter to the thickness of the compressed assembly. The safe rule is to have tests run on actual samples.

Head Diameter (H.D.) ranges between 1.75 and 2.75 times shank diameter for rivets produced by single-blow heading machines. Head diameters up to 3½ times shank diameter are possible . . . at higher cost.



Head Thickness (H.T.) ranges from 0.3 to 0.6 times shank diameter, depending on head shape: oval, flat countersunk, ideal, beveled flat countersunk or cone.

Shank Diameter (S.D.) of standard sizes ranges from .040" to .320".

How Clinched:

You have a choice of two clinches with Thomson Deep-Drilled Rivets, depending on the required strength: roll clinch or scored clinch. Roll clinch, produced by correctly-shaped anvils (either solid or spring pilot type), is stronger. Scored clinch is specified when clinch must be turned into the surface of the work.

Thomson Deep-Drilled Rivets are also clinched inside caps which match rivet heads to improve the appearance of the assembly and increase the strength. Washers (burrs) are also used to prevent the clinch from tearing loose by giving a stronger bearing against soft surfaces.

Design and engineering service:

Thomson analyzes your company's fastening problems and makes specific rivet and machine recommendations . . . at your request. When called in early, we can often meet your requirements with standard rivets and machines that eliminate the need for costly special fasteners and tooling. For work in progress, submit sketches, prints or samples for suggestions and quotations.

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Our new manual on all phases of riveting belongs in the hands of everyone who specifies or buys fasteners. It covers rivet types, applications, materials and other factors that determine the selection of the right design, rivet and machine for cutting fastening costs. Request your copy today. Write: Judson L. Thomson, Mfg. Co., Department B, Waltham 54, Mass.

JUDSON L. THOMSON MFG. CO., WALTHAM 54, MASS.

Circle 520 on Page 19

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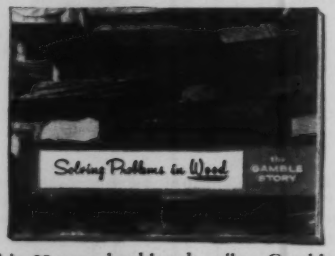

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Circle 521 on Page 19

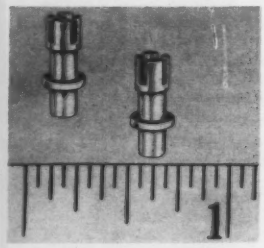
particles are trapped. Unit operates on pressures to 250 psi with efficient air filtration of flows up to 175 cfm, with minimum pressure drop. Available in pipe sizes of ¾ and 1 in. NPT, unit is 11½ in. long and 4½ in. in diam. **Wilkerson Corp.**, 1646 W. Girard Ave., Englewood, Colo. K

Circle 692 on Page 19

Castellated Terminal

accommodates boards from 1/32 to ¼ in. thick

No. 1010 castellated terminal is a furcated-end unit which permits locating more than one wire to the terminal from different directions. Available in six shank lengths from 5/64 to 19/64 in., it accommodates



boards from 1/32 to ¼ in. thick. Terminal is quality brass, finished in 0.0003 in. silver plate. **Cambridge Thermionic Corp.**, 445 Concord Ave., Cambridge 38, Mass. B

Circle 693 on Page 19

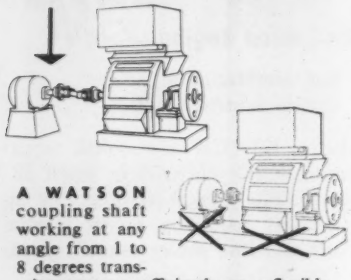
Electric Counter

hermetically sealed unit is explosionproof

Model 5-YE-9156-ER is a hermetically sealed electric counter with electric reset, designed for use on military and other applications where adverse operating conditions are a factor. Unit meets MIL-

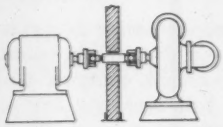
WATSON COUPLINGS Engineering Notes

How to Eliminate the Cost and Problems of Critical Alignment

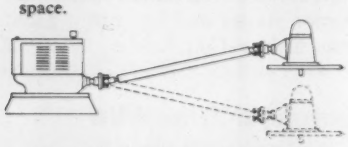


A WATSON coupling shaft working at any angle from 1 to 8 degrees transmits power as efficiently as a flexible coupling, yet offers substantial savings in design engineering time and installation cost. Angles up to 20 degrees can be handled (depending on RPM). No painstaking axial alignment is required; simple, low-cost concrete foundations poured on the site replace costly unit base plates.

In addition to substantial savings in engineering design and installation time and cost, the use of WATSON coupling shafts offers:



WIDEST LATITUDE IN LOCATION of driving and driven elements for best utilization of space, distribution of weight, isolation of motor or engine, provision for maintenance or working space.



PROVISION FOR RELATIVE MOVEMENT between driving and driven elements, either intentional or as a result of structural deflection or foundation shifts.

WATSON Coupling Shafts are promptly available in 9 sizes, 10 to 800 h.p., for speeds to 4,000 r.p.m. and more. Why not get the facts — now. 8-page Engineering Data Bulletin F-11 is yours for the asking; please address Dept. J-10.

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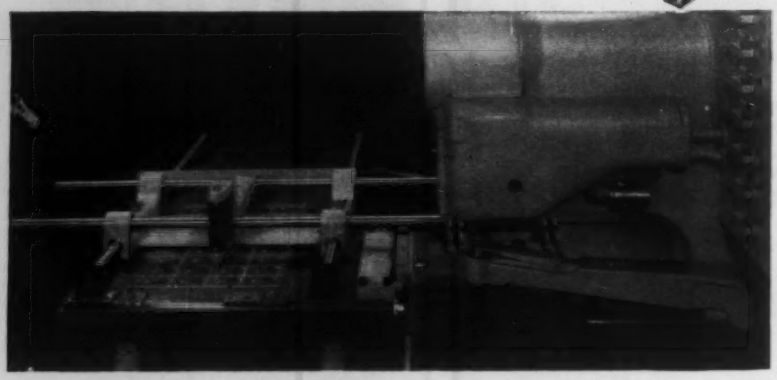

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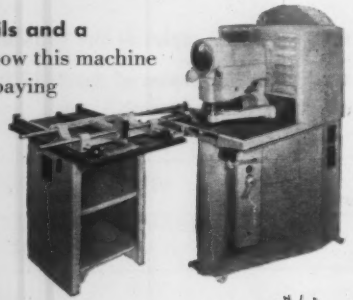

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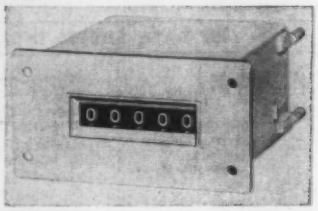
Circle 525 on Page 19

5272-A and similar specifications. Provision is made for mounting counter to front panel through four 8/32 threaded holes on face of counter. The explosionproof unit also has four mounting lugs at base for applications where additional support is needed, or for base installation. Hermetic-seal connector on bottom provides quick connection to power source. Counter is 3½ in. wide x 1⅞ in. deep x 3 7/16 in. high. Figures are 3/16 in. high x 9/64 in. wide, white on black back-



ground, with wide window opening for maximum readability. Speeds up to 1500 cpm or 25 cps are standard, with maximum resetting time of 105 millisec. Unit operates on 28 v dc. **Durant Mfg. Co.**, 1933 N. Buffum St., Milwaukee 1, Wis. K

Circle 694 on Page 19

Teflon Felt Material

for gaskets and seals

New all-Teflon felt material, consisting of Teflon fibers impregnated with Teflon resin, has a wide temperature range and can be used continuously from −100 to 400 F. Felt withstands attack by strong acids and bases, and is unaffected by water or any common fuels, lubricants, hydraulic fluids, or solvents. It is suitable for gaskets and seals exposed to severe corrosion and elevated temperatures. **General Plastics Corp.**, 165 Third Ave., Paterson, N. J. D

Circle 695 on Page 19

AC Generators

are brushless units

New 50, 60, and 400-cycle brushless ac generators are available in both single and three-phase outputs. All standard commercial voltages are available throughout range of sizes offered in brush-type alternators. The 60-cycle, three-phase sizes extend from 5 to 400

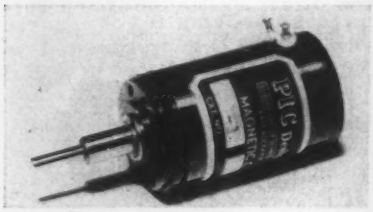
kw, and 400-cycle units from 1 to 250 kw, revolving-field types in all standard commercial voltages through 600 v. Units are available in single and two-bearing, close-coupled designs for direct connection to industrial engines, and can be supplied in standard two-bearing design for belt-drive applications. **Kato Engineering Co.**, Mankato, Minn. J

Circle 696 on Page 19

Magnetic Clutches

in both single and double-ended models

Type DZ magnetic clutches in Mark 8 or size 18 frame are 1¾ in. in diam, and are available in both single and double-ended units to provide a variety of applications. They are for use with ¼-in. diam shafts. All materials and finishes



meet military specifications. Power consumption is 3 w, and minimum output torque is 16 oz-in. Unit operates on 24-28 v dc. **PIC Design Corp.**, 477 Atlantic Ave., East Rockaway, L. I., N. Y. D

Circle 697 on Page 19

Panel Meter

has high readability and true linearity

Model MM-5 panel meter is designed for applications requiring high instrument accuracy and readability, combined with modern styling. Unit occupies 4⅝-in. panel space and mounting space of 3½ in. Moving-coil mechanism achieves

Stearns Tech-notes on electro-magnetic BRAKES CLUTCHES

(choice of the leading motor manufacturers)

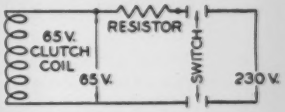
(Third of a Series)

HOW TO UTILIZE NORMAL ELECTRICAL CHARACTERISTICS OF MAGNETIC CLUTCHES FOR *Matched-to-the-Machine* PERFORMANCE

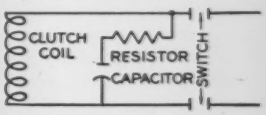
Electrical characteristics of the more commonly used magnetic clutches are basically quite similar. Stearns engineers, however, with knowledge gained from forty years of design and application experience, are experts at turning any of these natural characteristics to advantage to provide true *Matched-to-the-Machine* performance. Here are but a few of these "tricks of the trade," with the reasoning that made them possible:

The more commonly used electric clutches operate on direct current only, and must be considered an inductive load in an electrical circuit. Even though normal operating speed of electrical clutches is generally quite rapid, and adequate for many applications . . . Stearns engineers have long recognized that because of a clutch's inductive nature, a certain amount of electrical inertia is present — which introduces a time delay in its engagement and disengagement.

1. Engagement time is a function of the ratio of clutch coil inductance to circuit resistance. From this it follows that by increasing circuit resistance for a given clutch inductance, clutch engagement time will be speeded up. In actual practice this can easily be accomplished by connecting a resistor in series with the clutch coil, and operating the system on a higher voltage — as shown in the inset schematic to the right.



2. On many applications, clutch disengagement can be speeded up by employing a slightly different circuit employing a resistor and capacitor in parallel with the clutch coil. In this case, opening the switch establishes a damped oscillatory wave in the clutch coil circuit. The clutch disengages shortly after the negative lobe of this wave appears. In some cases the resistor may be omitted, since its primary purpose is to limit current spikes caused by capacitor charging current when the switch is closed. Component values can best be determined experimentally since such variables as mechanical inertia of the individual clutch armature and inductance must be considered. Typical values which might be used are a 600 W.V.D.C., 0.5 mfd capacitor, and a 5 watt, 20 ohm resistor.



3. If extremely rapid engagement and disengagement are required, Stearns engineers have successfully employed a combination of the two circuits shown above . . . or "go all the way," and incorporate electronic circuitry using thyratron tubes.

For practical solutions to your starting-stopping problems . . . you can call on Stearns with confidence. For clutches and brakes — whatever your requirements — Stearns has a standard unit, or will design and build units specifically for your application. Stearns brakes and clutches offer precision control . . . smooth starts and stops . . . fast, easy installation and maintenance . . . plus important cost savings in installation and operation unobtainable elsewhere.

For Superior Service — Performance . . . Specify Stearns!
Call the Stearns representative in your vicinity for complete data on electromagnetic clutches, brakes, and clutch-brake combinations. Or write, outlining your specific requirements directly to . . .

Stearns ELECTRIC CORPORATION
120 NORTH BROADWAY
MILWAUKEE 2, WISCONSIN

Circle 526 on Page 19

The Sylvania Internal Circuit Breaker was developed primarily for protection of electric motors such as are used in windshield wipers, window lifts, seat actuators, antenna lifts, air compressors, vacuum boosters and other automotive power equipment. Mounted adjacent to the brush holders, this two-piece bimetal breaker is ambient compensated, self-re-closing and protects against locked rotor or stall current conditions. All in the series are mounted on a standard base which permits easy design within small motor space limitations.

The two legs are Chace Thermostatic Bimetal. The U-shaped leg has the low expansive side on top, while the short straight section is opposite, making the unit partially ambient compensated. The design insures minimum derating from initial SAE calibration at ambient temperature levels of −20° to 200°F. The long initial on-time under load eliminates trip-outs due to short term overloads.

As the modern motorcar becomes more complex with its scores of motor-driven devices for safety, comfort, convenience and improved operation, the hazards of fire and serious damage are multiplied. Sylvania offers "permanent protection" and "continuous service" based on the always predictable performance of our precision product. Our third of a century in thermostatic bimetal development and production is positive assurance that your two and a half to six thousand dollar investment and Sylvania's reputation are in good hands. And when your need for a temperature-actuated device approaches the design stage, send for our 1958 edition of "Successful Applications of Chace Thermostatic Bimetal," containing many pages of valuable design data.

W. M. CHACE CO.
Thermostatic Bimetal
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Circle 527 on Page 19

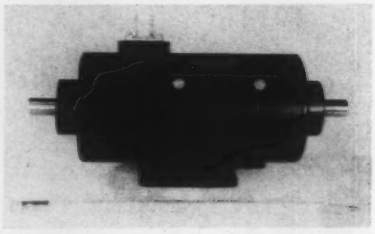
higher flux level and more symmetric flux distribution than core or external-magnet types. It provides tracking held to ½ per cent of full scale when plotted linearly or with a protractor reference for deflection angles up to and including 100 deg. **Marion Electrical Instrument Co.**, Grenier Field, Manchester, N. H. B

Circle 698 on Page 19

Double Gearmotor

has planetary gear reduction at each end

New 115-v, 400-cycle, single-phase capacitor start and run motor is about 5 in. long and 2½ in. in diam. It is equipped with a planetary gear reduction at each end. Output shaft at one end produces 1300 rpm at 144 oz-in. torque, and output shaft at other end pro-



duces approximately 7 rpm and 160 oz-in. torque. Motor is designed for intermittent duty and is equipped with thermal protector. It uses a 10-mfd capacitor and draws 5.5 amp under load. **Western Gear Corp.**, P.O. Box 182, Lynwood, Calif. L

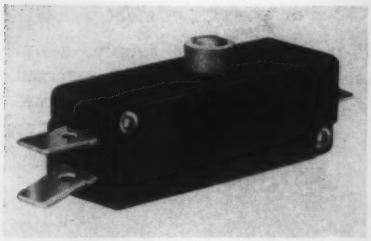
Circle 699 on Page 19

Snap-Action Switch

for use in automatic devices

Type A snap-action switch is furnished with a hinged-lever actuator, as well as with button, overtravel

plunger, leaf, and leaf-roller actuators for use in automatic devices such as washer-dryer units, vending machines, and retractable automobile tops. Switch has step construction where molded case halves meet, providing increased resistance to moisture and dust. Electrical rating is 15 amp, 125, 250 v ac; ½ hp, 125 v ac; 1 hp, 250 v ac. Quick-connect terminals provide for fast,



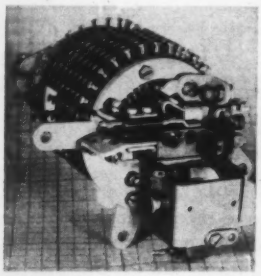
secure electrical connections. **Unimax Switch Div., W. L. Maxson Corp.**, Ives Road, Wallingford, Conn. B

Circle 700 on Page 19

Miniature Stepping Switch

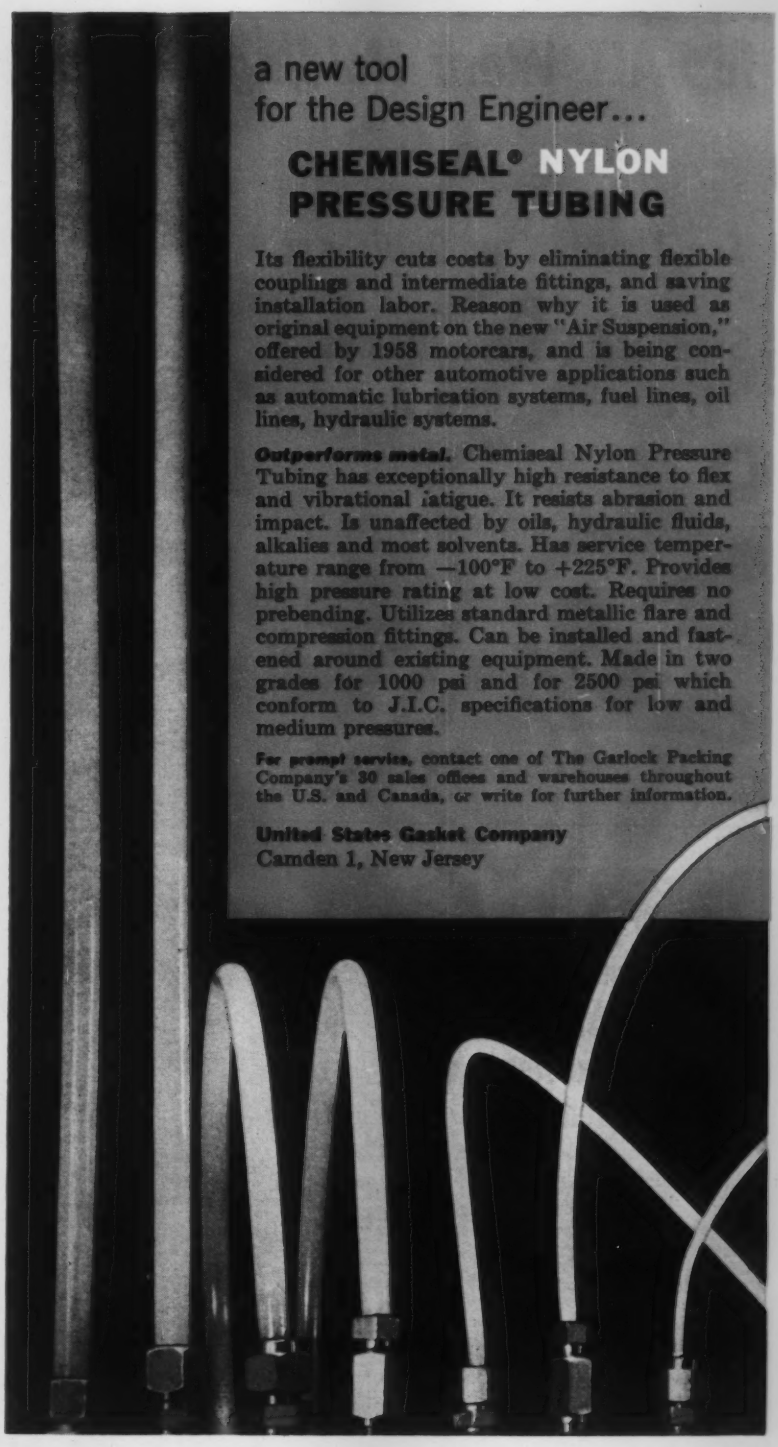
for use in automatic switching and timing-control circuits

Miniature high-speed stepping switch, designated Uniselector, is designed for use in automatic switching and timing-control circuits. Unit operates at speeds up to 80 steps per sec on impulse drive from a power supply of 24, 50, or 110 v dc. Switch has maximum of 12 banks, each with 30 individual contacts mounted in a complete circle. When seven or less banks are required, a se-



quence switch can be fitted which consists of an auxiliary bank of contacts and wiper assembly. Sequence switch wiper steps once for each complete revolution of main wiper assembly. Wipers are bridging or nonbridging. **Imtra Corp.**, 11 University Rd., Cambridge 38, Mass. B

Circle 701 on Page 19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Circle 528 on Page 19

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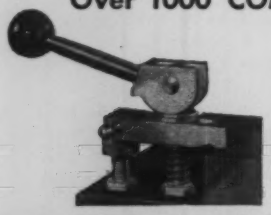

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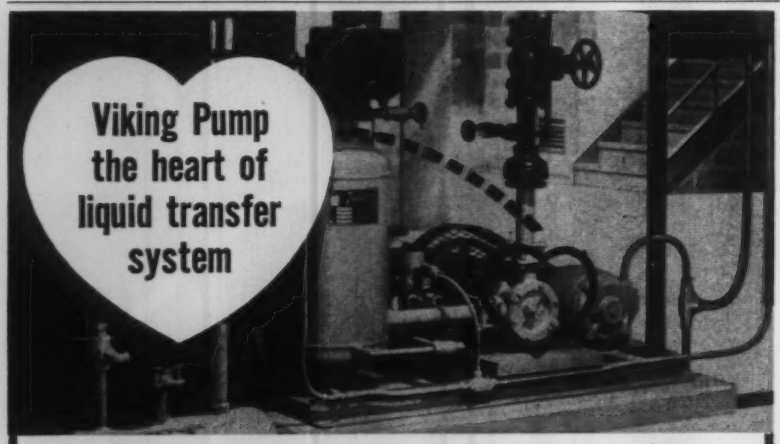
Circle 529 on Page 19



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Circle 530 on Page 19

ENGINEERING DEPARTMENT

EQUIPMENT

Power Supply

provides external 12-v dc power

All-transistor power supply, designated Model 60A, provides external 12-v dc power for portable, battery-

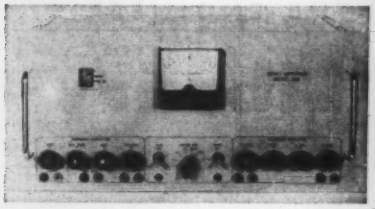
powered test instruments. Unit handles any four instruments simultaneously without interaction due to common power-supply impedance. Four outputs on panel are individually filtered, and additional filter is provided for power supply proper. Unit provides a stable dc source comparable to output of a battery. Ripple is less than 200 mv, and dc source impedance is less than that of a battery. The 6 x 8 x 6¼-in. instrument uses printed circuitry and miniature components. **Alectra Div., Consolidated Electrodynamics Corp.**, 300 N. Sierra Madre Villa, Pasadena, Calif. L

Circle 702 on Page 19

Servo Amplifier

incorporates built-in metering circuit

Model 601 servo amplifier drives dc torque motors or provides excitation to and accepts feedback signals from either ac or dc pickoff devices. Built-in metering circuit provides self-contained measurements of all signals checked in any servo system. Unit has a regulated power supply mounted on a subchassis as part of the amplifier. Suitable for bench use, instrument is only 8¾ in. high. Independent level and balance controls enable current range



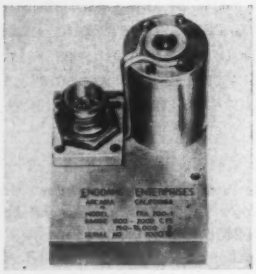
from 8 to 25 ma without interaction. **American Measurement & Controls Inc.**, 240 Calvary St., Waltham, Mass. B

Circle 703 on Page 19

Accelerometer

records from 250 to 10,000 g

Triaxial recording accelerometer senses and records data for plotting acceleration vs. time under extremely rigorous conditions. Three sensing elements are located in mutually perpendicular planes. Unit is self-contained, and records from



250 to 10,000 g. Maximum dimension is 2 1/16 in., and weight is 6 oz. **Engdahl Enterprises**, P. O. Box 823, Arcadia, Calif. L

Circle 704 on Page 19

Photocopy Unit

accommodates originals to 15 in. wide of any length

Transcopy Meteor, a compact, high-speed photocopy unit, exposes, develops, and prints finished copies of originals up to 15 in. wide of any length in ½ min or less. Unit is designed for use under fluorescent or bright office lighting, using built-in filter safety paper. Copier is 26½ in. long, 15½ in. wide, and 9¼ in. high. It can be plugged into standard electrical outlets, and no installation is necessary. **Remington Rand Div., Sperry Rand Corp.**, 315 Fourth Ave., New York 10, N. Y. D

Circle 705 on Page 19

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Circle 531 on Page 19

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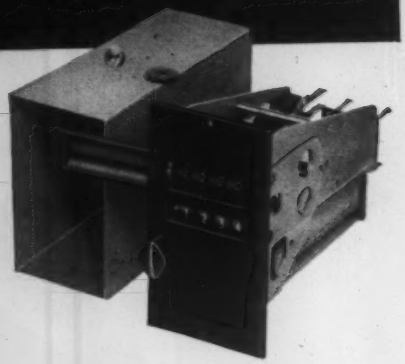

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Circle 533 on Page 19

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Presented in this book are the fundamental principles and methods underlying the mechanics of machinery.

The first section of the book covers the various mechanisms such as linkages, cams, gears, and intermittent motion mechanisms. In the second section, the kinematics and dynamics of machinery are discussed.

Fourth National Symposium on Vacuum Technology Transactions. *Edited by Wilfred G. Matheson; 176 pages, 8½ by 11 in., clothbound; published by Pergamon Press Inc., 122 East 55th St., New York 22, N. Y.; available from* MACHINE DESIGN, *$12.50 per copy postpaid.*

Included in this symposium are papers on the fundamental developments of vacuum technology and engineering, new methods and techniques for obtaining high vacuum, instrumentation, controls, and other vacuum devices.

Industrial Electronics Handbook. *Edited by William D. Cockrell; 1408 pages, 6 by 9 in., clothbound; published by McGraw-Hill Book Co., 330 West 42nd St., New York 36, N. Y.; available from* MACHINE DESIGN, *$22.50 per copy postpaid.*

This handbook provides reference material on basic engineering and mathematics, physical laws, control elements, power supplies, control circuits, circuit applications, mechanical design, ultimate utilization requirements, and technical information sources.

Among subjects covered are computers, instrumentation, regulators, relays, transducers, amplifiers, and military and industrial utilizations. Mechanical design, testing, field installation, industry and customer preferences, and environmental requirements of electronic equipment are treated.

New Standards

American Standards. *Each publication is 8 by 10½ in., paperbound and side-stapled. Copies are available from American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y.*

The following standards are available:

American Standard Plain Washers, ASA B27.2-1958; 10 pages, $1.00 per copy.

American Standard Butt-Welding Ends, ASA B16.25-1958; 10 pages, $1.00 per copy.

American Standard Graphical Symbols for Fluid Power Diagrams, ASA Y32.10-1958; 15 pages, $1.50 per copy.

Manufacturers' Publications

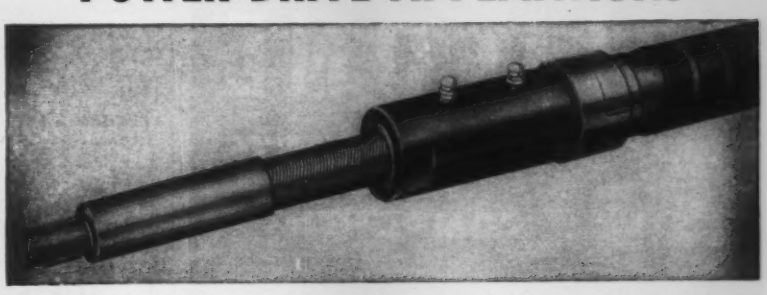
Transistor Manual, Third Edition. *168 pages, 6 by 8½ in., ringbound; published by and available from General Electric Co., Semiconductor Products Dept., Syracuse, N. Y., $1.00 per copy.*

This reference guide for transistors presents the theory and application of transistors to various circuits. Also included is a tabulation of the characteristics and specifications of all transistor types manufactured to mid-1958.

Static Control Application Manual. *152 pages, 8½ by 11 in., paperbound; published by and available from General Electric Co., Schenectady 5, N. Y.; $5.00 per copy.*

This manual discusses the nature of static control and explains why, when, and where it should be used for general industrial applications. Specific sections of this manual cover the logic concept, fundamental electrical and mechanical descriptions of static control, operation of general purpose control components, circuit design, panel layout, and system check-out procedures.

HOW TO SELECT FLEXIBLE SHAFTING FOR POWER DRIVE APPLICATIONS



1¼-inch STOW Power Drive flexible shaft with core assembly pulled out of casing.

For Power Drive applications, the following factors must be considered:

1. Torque (Lb. In.) to be transmitted. (The starting torque should be used in making selections.)

2. Operating Speeds (RPM) — If the maximum speed is higher than the rated speed, torque ratings in the table below do not apply. To find the torque capacity for flexible shafts operating at speeds higher than the rated speeds, multiply the maximum dynamic torque capacity by the rated speed, and then divide by the operating speed. (See example.)

3. Operating Radius—In making the selection from the table below, the radius of the smallest bend in the flexible shaft should be used.

Ratings — The ratings for flexible shafts shown in the table below apply under the following conditions:

1. When the flexible shaft is adequately supported by clamps along its length. (For unsupported shafts, multiply the calculated torque by a safety factor of 1.6—see example below.)

2. When the flexible shaft is operated in the wind-up direction, which tends to tighten the outer layer of wires. (Flexible shafts operated in the unwind direction will transmit only about 60% of the rated torque.)

3. When the flexible shaft is in continuous operation. Note: **the ratings are based on temperature rise. When the operation is intermittent, the ratings in the table may be exceeded. Consult Stow engineers for specific recommendations.**

RATED SPEED R.P.M.	MAXIMUM DYNAMIC TORQUE CAPACITY (LB. IN.) STRAIGHT AND CURVED SHAFTS RADIUS OF CURVATURE IN INCHES									Wgt./ C. Ft.	Core Dia.	Core No. and Type	Shaft Size
	50 to Strgt.	25	20	15	12	10	8	6	5				
4,500	2.4	2.2	2.0	2.0	1.92	1.9	1.7	1.5	1.25	3.0	.124/.128	2049 MH	13
3,800	7.0	6.4	6.0	5.8	5.4	5.0	4.6	3.6	2.0	4.5	.148/.152	2081 MH	15
2,900	9.4	8.6	8.0	7.6	7.0	6.6	6.0	4.8	3.4	7.0	.185/.189	5108 MH	19
2,500	22.0	20.0	18.8	17.6	16.0	15.0	12.6	10.8	9.0	12.5	.247/.252	8924 MH	25
1,800	30.0	28.0	26.4	25.0	23.0	21.0	18.0	14.0		20.0	.308/.313	8925 MH	31
1,800	33.8	31.5	29.7	28.1	25.9	23.6	20.2	15.8		20.0	.308/.313	8969 T	31
1,800	36.0	33.0	31.6	30.0	28.0	26.0	22.0	18.0	11.0	21.0	.324/.329	2034 A	31
1,500	80.0	66.0	63.0	58.0	51.0	46.0	37.0	22.0		28.5	.368/.374	2035 A	38
1,500	60.0	54.0	50.0	46.0	42.0	38.0	30.0	24.0		29.0	.387/.393	8970 MH	40
1,500	90.0	81.0	75.0	69.0	63.0	57.0	45.0	36.0		29.0	.387/.393	8971 T	40
1,150	136.0	110.0	104.0	94.0	80.0	72.0	56.0			50.5	.497/.503	8999 A	50
1,150	148	124	110	92	72	56				53.5	.505/.511	6940 T	50
900	248	200	176	124	84					78.5	.610/.618	6997 T	63
900	220	204	192	180	152	130				80.5	.630/.638	7731 A	63
750	340	224	156	76						117	.747/.753	2056 T	75
600	760	520	420							205	.998/1.004	2057 T	100
440	1,500	720								343	1.298/1.304	2058 T	125

EXAMPLE — How to use the table:

The problem is to transmit ½ H P at 1700 RPM through an unsupported flexible shaft in a 25" radius, estimated starting torque 150% of normal operating torque.

1. Calc. Torque (lb. in.)—
$$\frac{HP \times 63000}{RPM} = \frac{.5 \times 63000}{1700} = 18.5$$
2. Correction factor for starting torque 1.5 x 18.5 = 27.75
3. Correction factor for unsupported shaft 27.75 x 1.6 = 44.4 lb. in.
4. Refer to Table above. Read downward in column under 25" radius until you find a core having a rating of at least 44.4 lb. in. In this case we find that core no. 8970 is rated 54 lb. in. at 1500 RPM. Since the given speed is 1700 RPM, multiply 54 by 1500 and divide by 1700 .54 × 1500 ÷ 1700 = 47.6 lb. in. (rated torque at 1700 RPM). Therefore, Core No. 8970 is correct.

STOW

For Engineering Bulletin No. 570 and a free torque calculator, write

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Circle 534 on Page 19

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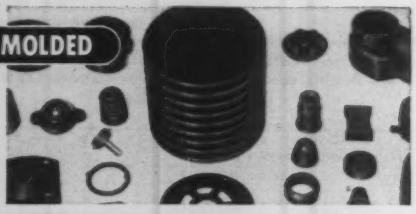
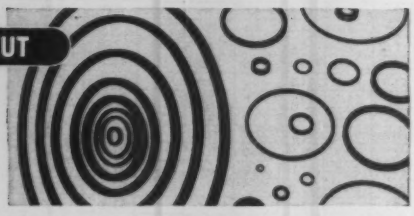
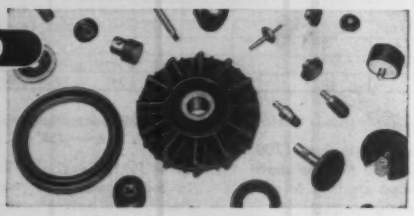


LATHE CUT



BONDED



GORSIL compounds are now available for adaptation to your next part problem that involves temperature.

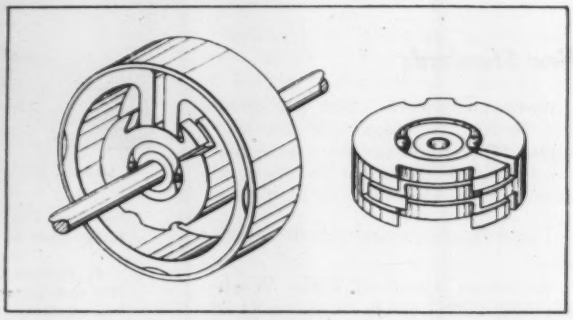
Goshen Rubber Co., INC.

1710-8 S. TENTH ST., GOSHEN, INDIANA

NOTE WORTHY

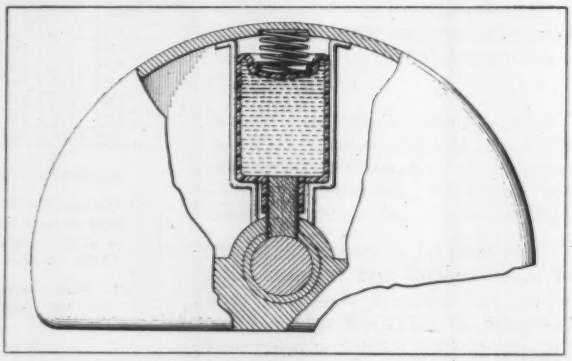
Patents

Torque-Limiting Clutch



Increasing torque load on a friction clutch forces balls further into wedge openings formed by a cam-shaped hub and a slotted ring member surrounding the hub. The arrangement of the slots allows the ring to expand circumferentially due to outward force from the balls. As the ring expands, the net distance decreases between gripping hooks formed on the ring outer surface. This action brings closer together two ears, integral with a cylindrical friction shoe, and carried between the gripping hooks. As the ears close, the circumference of the shoe decreases. Consequently, the friction force the shoe exerts outward on the inner surface of the clutch casing also decreases. A torque load is reached at which the clutch slips. The clutch functions in either direction of rotation. *Patent 2,847,836 assigned to Collins Radio Co., Cedar Rapids, Iowa, by Glen B. Morris.*

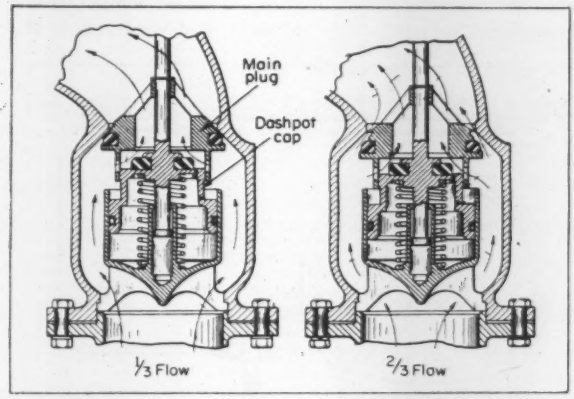
Bottle-Fed Bearing



Lubricant is fed to a plain bearing at a constant rate with minimum loss, regardless of the attitude of the bearing, by a conventional plastic "squeeze" bottle. The flexible bottle is contained by a rigid holder and a spring. The neck of the bottle is completely filled

by a wick which leads oil directly to the bearing. Since the wick functions by capillary action, physical position of the assembly does not affect rate of flow. The bottle is refilled by injection through a small opening which is later patched. *Patent* 2,850,336 *assigned to General Electric Co. by Richard W. Dochterman.*

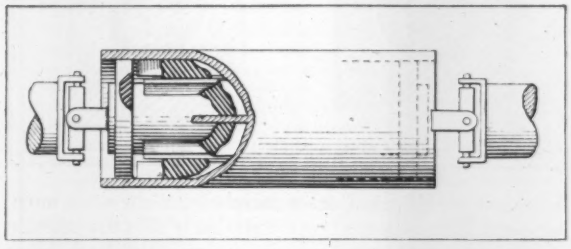
Soft-Closing Valve



A dashpot, which "breathes" the fluid transmitted, softens the closing of a valve to prevent damage to valve parts and to the line, as by fluid hammer. Linear positioning of an axial stem, controlled by external positive stops, adjusts the flow volume through the valve. To obtain one-third flow, downward travel of the stem depresses the dashpot cap to uncover holes in the cylindrical extension of an adjacent main plug. To obtain two-thirds flow, further downward travel of the stem opens the main plug. To close the valve, the stem setting is released, the flow immediately carries the main plug to its seat, and the dashpot expands relatively slowly to complete the closing. *Patent* 2,843,148 *assigned to Buckeye Iron and Brass Works, Dayton, Ohio, by Alfred W. Rymills.*

Cushioned Shaft Coupling

Unusually long and thin, a cylindrical shaft coupling transmits high torque, and can accommodate minor

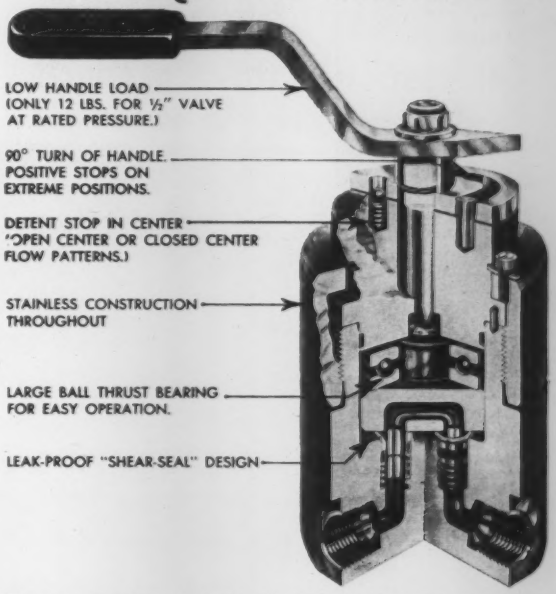


shaft misalignment and momentary load variations. The outside cylinder carries straight axial fins rigidly fixed on its ID. These fins are equally spaced between fins rigidly fixed on the OD of a smaller inner cylinder. Spaces between fins are filled with loose strips of resilient nonmetallic material. To change performance

10,000 P.S.I.

4 WAY VALVE

FOR LIQUIDS OR GASES


LOW HANDLE LOAD (ONLY 12 LBS. FOR ½" VALVE AT RATED PRESSURE.)
90° TURN OF HANDLE. POSITIVE STOPS ON EXTREME POSITIONS.
DETENT STOP IN CENTER "OPEN CENTER OR CLOSED CENTER FLOW PATTERNS.)
STAINLESS CONSTRUCTION THROUGHOUT
LARGE BALL THRUST BEARING FOR EASY OPERATION.
LEAK-PROOF "SHEAR-SEAL" DESIGN

This new four-way valve series comes in pipe sizes from ¼ to 1 inch, but may be obtained with tube, AND 10050, or any preferred special high pressure connection. It will withstand surges of up to 15,000 P.S.I. without damage to the valve's sealing qualities. It is designed for a burst pressure of 30,000 P.S.I.

No port to port leakage occurs in the detented positions because of the exclusive "Shear-Seal" design.

Long, maintenance-free service is assured because the optically flat metal to metal sealing surfaces of the sealing rings and mating rotor faces are protected by staying in constant intimate contact; flow is always through the center of the "Shear-Seal", never across sealing surfaces (as in conventional valve design). Sealing qualities actually improve as the self aligning "Shear-Seals" lap themselves to a more perfect fit with each valve operation.

Of course, there is no external shaft leakage, because the pressure is confined to the flow passages.

Write for Catalog 58-59

CONTROL VALVE DIVISION

Barksdale valves

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

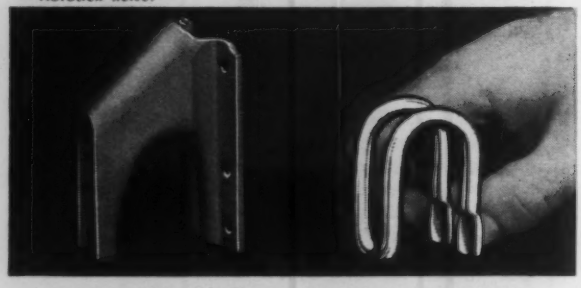
Circle 536 on Page 19

CREATIVE Design Engineers

Widen your creative horizons with versatile Wire/Strip design and fabrication. Wire/Strip has much to offer . . . strength, adaptability, resiliency, lightness, durability, and the decorative nature of wire increases the salability of products.

Cut costs • Improve products with remarkable Wire and Strip

MOTOR MOUNT and GUARD for Industrial Heater—Original was costly, heavy and noisy. The Titchener redesign of Wire/Strip construction combined the mount with the guard and reduced assembly and fabrication costs; is lighter; enhances appearance; and the natural resiliency of wire eliminated excessive vibration noise.



Lifting Lug IMPROVED—Wire replaced sheet steel and solved a painting and rusting problem. Titchener Wire redesign permitted adequate paint coverage and gave better, stronger appearance.

Learn how you can cut costs and improve your product with Wire/Strip assemblies. Send a drawing, photograph or sample of your product; better yet, visit our plant . . . there's no obligation.

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- ☐ "How Wire Construction Reduces Costs"
- ☐ "Wire Handles by Titchener"
- ☐ "Use of Wire Construction in Product Design"
- ☐ Please have a Titchener Field Engineer call

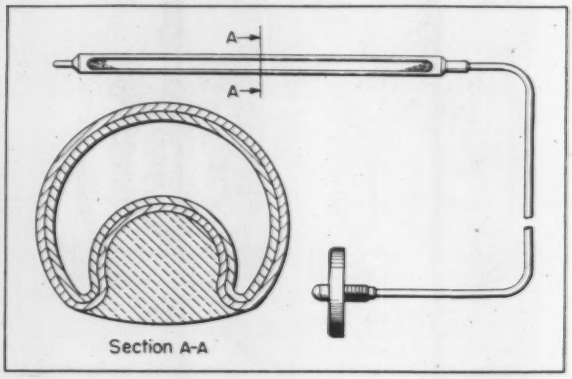
E. H. TITCHENER & CO.

Dept. 3307 67 Clinton St., Binghamton, N. Y.

of the assembly, strips can be replaced readily with others of the same size but different properties. Small OD of the assembly minimizes its angular momentum. *Patent 2,849,871 assigned to the United States of America by Kurt G. F. Moeller.*

Self-Compensating Thermometer

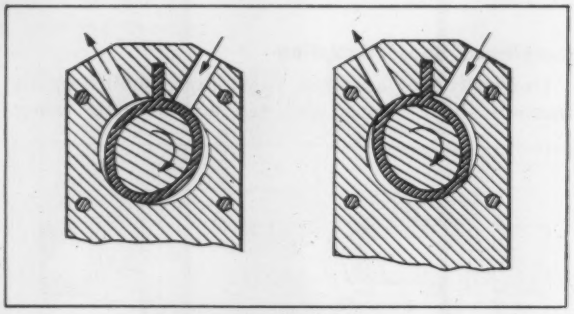
Bimetallic construction of the bulb in a pressure-bulb thermometer eliminates the error in temperature measurement caused by expansion and contraction of



the bulb itself. In section, the bulb is crescent-shaped. Whether temperature falls or rises, the tendency of one arc of the crescent to change shape is countered by an opposite tendency of the other arc. Thus, interior volume remains constant, and only the change of pressure of the enclosed medium activates indicators or controls. *Patent 2,846,884 assigned to Robertshaw-Fulton Controls Co., Greensburg, Pa., by James U. Daly.*

Elliptical-Impeller Pump

Simplicity of construction and positive displacement in operation are features of a pump in which a resilient



liner and an elliptical drive member are the only moving parts. The elliptical core completely fills the interior of the liner and continuously deforms the liner as it moves crescent-shaped pockets of fluid to the outlet port. Inlet is always sealed from outlet by pressure of lobes of the ellipse against the chamber wall and by a reciprocating tongue integral with the liner. *Patent 2,849,962 assigned to United Shoe Machinery Corp., Flemington, N. J., by C. Walton Musser.*

NEW AGASTAT®

HAS LONGER OPERATING LIFE

The Agastat time/delay/relay has been completely re-designed, inside and out, to make every moving part last longer and operate more reliably. Here are some other important advantages:

- Dial adjustment for ease and accuracy
- Five timing ranges, covering an overall range of from 0.08 seconds to 15 minutes
- Timed intervals remain the same through repeated readjustments
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- Measures only 4-9/16 x 2-9/16 x 2-5/8"
- All contacts are flexible contacts
- Contacts are larger for fast heat dissipation

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AGA DIVISION

Elastic Stop Nut Corporation of America

1027 Newark Avenue, Elizabeth, New Jersey

Pioneers in Pneumatic Timing

Circle 538 on Page 19

NEED A QUIET MOTOR?

If your product will sell better by keeping quiet, we'll help you make it whisper. Hard-to-hear Jack & Heintz *Customized* motors are making silence golden on door operators . . . on meat slicers . . . on floor polishers, and the like.

We'll customize beyond mere quiet. Give you special torque, high or low L/D ratio, special contour or finishes. Submersibility is possible in water, oil, gasoline or other fluids. Or, if you foresee high temperature operation, J&H will customize to meet it.

So don't let a limited standard motor compromise what you want to do. It's not worth the sacrifice in product performance and salability.

Call Jack & Heintz for a motor that fits your design perfectly. Our range is ⅓ to 3 hp, up to 15 hp for submersibles.

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COMMERCIAL MOTOR DIVISION

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TRU-SEAL
TEFLON SEAL
Saves hours in piping installations
PAT. PENDING
Eliminates leaks in oil, air, water, vacuum, chemical lines
Tru-Seal saves hours in assembling piping installations because it enables you to run your pipe lines in any direction you wish, quickly and easily—without having to recut and re-thread piping sections. Wherever used on air, oil, water, steam, vacuum or chemical lines, it seals perfectly at —100° F. to plus 500° F.—*without the use of pipe dope.* Its installation requires only light tightening torque, thus eliminating over-tightening damage to valves, pumps, compressors, and other fittings.
For further information write
TRU-SEAL DIVISION
FLICK-REEDY CORPORATION
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"Miller Fluid Power" is also a Div. of Flick-Reedy Corp.
1 Thread Tru-Seal on pipe or fitting as far as it will go hand tight.
SEAL SIDE
2 Thread pipe or fitting 3 threads into port. Point in desired direction.
3 Tighten Tru-Seal to complete leakproof assembly (only light torque required).

Circle 539 on Page 19

Circle 540 on Page 19

now-

SHEAR-PROOF ALLOY STEEL

DRIV-LOK PINS

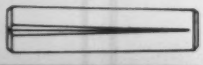
for maximum resistance to

shear *shock* *fatigue*

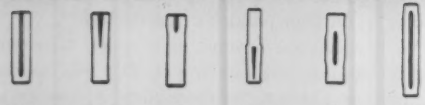
- Drill a hole and drive them in . . . they're grooved and self-locking
- Provide the ultimate in physical properties at moderate cost
- Re-usable without loss of holding power

Now, you can get the efficiency, convenience and proven economy of DRIV-LOK Grooved Pins PLUS maximum resistance to shear, shock and fatigue, by specifying or installing *Shear-Proof* DRIV-LOK Pins. Made of alloy steel, heat treated to provide optimum physical properties and high shear values, Shear-Proof DRIV-LOK Pins are designed for critical applications where ultimate strength and reliability are mandatory. They are replacing alloy dowels, bolts, key and set screw assemblies, hollow pins (used singly, or one inside the other) in widely varied applications . . . thus saving time, labor and material. Write for special Shear-Proof DRIV-LOK Pin Catalog. Sample Type A Shear-Proof Pins furnished free on request.

type A standard



SPECIAL TYPES TO ORDER . . .



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COMPARE TYPICAL SHEAR VALUES (Minimum double shear strength in pounds)	Diameter	Slotted Spring Pins	Coiled Spring Pins HEAVY DUTY	SHEAR-PROOF DRIV-LOK PINS
	3/32	1000	1030	2040
	1/8	2100	1840	3690
	5/32	3000	2880	5720
	3/16	4400	4140	8240
	1/4	7700	7360	14720
	5/16	11500	11500	22960
	3/8	17600	16580	33160
	7/16	20000	22540	45000
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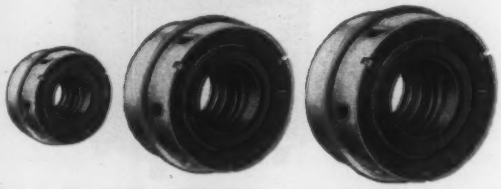
DRIV-LOK SALES CORPORATION

715 PARK AVENUE • SYCAMORE, ILLINOIS

Circle 541 on Page 19

NEW HY DUTY J-2 SEALS

FOR THOSE APPLICATIONS THAT REQUIRE THE BEST



New Schwitzer Aquatite Seals of exceptional durability— for ⅜", 1" and 1⅛" diameter shafts.

The economy is found in its long life and dependability.

An unbeatable combination when used with the Schwitzer Ceramic Nose Pump Impeller.

SCHWITZER CORPORATION

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Write For Bulletin 121 To Answer Your Seal Problem

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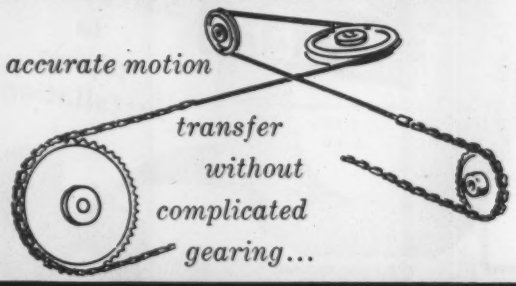
MORE DESIGN FREEDOM



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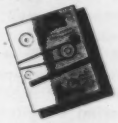
Provide precise, positive motion transfer through several planes simultaneously with no cable slippage...no complicated gearing. Unlimited center-to-center selection for miniature and sub-miniature assemblies in servo systems, gyro systems, special cameras, electronic equipment, and small precision instruments. Less weight, cost, maintenance —wider tolerances. Designed to operate around minimum 7-tooth sprocket with root diameter of .250 inches. Chain pitch .1475 inches; Weight .45 oz. per lineal ft. Material: stainless steel, or other materials, including non-magnetic beryllium copper.

NEW CATALOG



Contains useful application data, specifications, tables on chain pitch and sprocket sizes, suggestions for calculating center-to-center distance. *Write for yours today.*

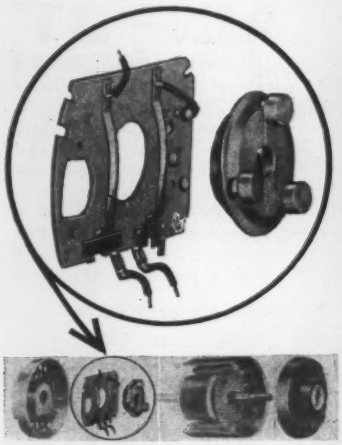
123 E. Montecito Avenue, Sierra Madre, California

Sierra ENGINEERING CO.

T. M. REG.

Circle 543 on Page 19

Leading Motor Manufacturers Use
SYNCRO-SNAP CENTRIFUGAL SWITCHES
To Cut Out Starting Windings



• These switches operate on a fundamentally new principle which avoids frictional components and results in positive, predictable, instantaneous snap-action every time for at least 1.5 million cycles.

Syncro Snaps are available in short runs or production quantities in capacities now up to 7.5 H.P. and are especially suitable for difficult multi-speed motor switching applications. The large selection of standard sizes will fit most applications. The wide range of available cut-out speeds can match maximum pull-up torque requirements, and the equally wide range of cut-in speeds will eliminate regeneration effects especially in large motors. Naturally, matching stationary switches can be furnished in open or closed types with required contact capacity.

...And another intriguing advantage of Syncro Snap Switches is that they are available at less cost than you could make them yourself, even if they weren't covered by patents and patents pending (No. 2,616,682).

Send requirements today for specific data or quotation.

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26 W. MONROE ST. BEDFORD, OHIO

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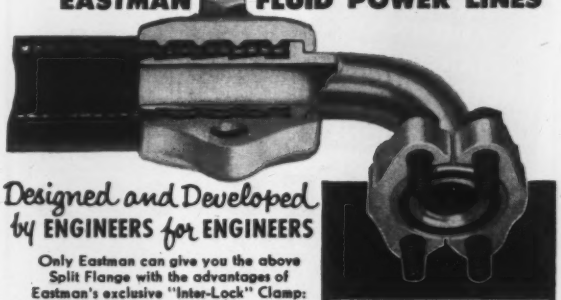
EASTMAN FLUID POWER LINES



Designed and Developed by ENGINEERS for ENGINEERS

Only Eastman can give you the above Split Flange with the advantages of Eastman's exclusive "Inter-Lock" Clamp:

1. **"Inter-Lock" Clamp for Best Hose Connection** — Accurate machining assures alternate positioning of ribs of clamp and barbs of insert—**avoids pinching and weakening of hose**—creating exclusive Eastman Inter-Lock grip.
2. **Split Flange for Tighter Seal at High Pressures**—Cuts production and replacement costs with a No-Thread, No-Leak "O" Ring Connection which eliminates threads, sealing compounds, spiral leaks and housing distortion.

Rely on Eastman for quality—first to be specified by America's leading OEM's.

Permanently Attached Flanged Head Couplings: ¼" thru 2" 375 to 5000 p.s.i.

Clamp Type Coupling with Split Flange Stems: ¼" thru 2" 375 to 5000 p.s.i.

Write for Eastman Inter-Lock Clamp Bulletin No. 40.

Eastman
MANUFACTURING COMPANY
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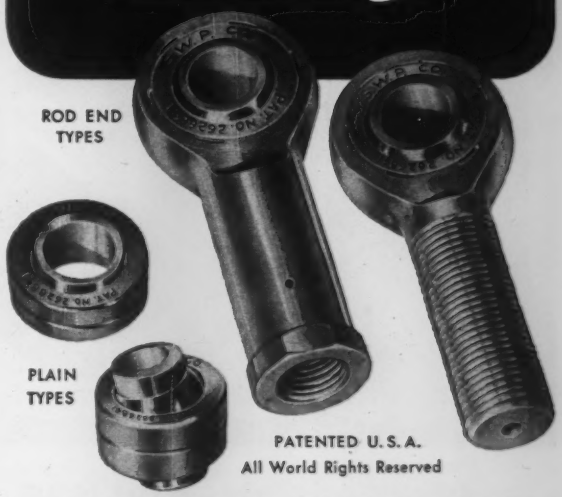
"MONOBALL" Self-Aligning Bearings



ROD END TYPES

PLAIN TYPES

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CHARACTERISTICS

	ANALYSIS	RECOMMENDED USE
1	Stainless Steel Ball and Race	For types operating under high temperature (800-1200 degrees F.).
2	Chrome Moly Steel Ball and Race	For types operating under high radial ultimate loads (3000-893,000 lbs.).
3	Bronze Race and Chrome Moly Steel Ball	For types operating under normal loads with minimum friction requirements.

Thousands in use. Backed by years of service life. Wide variety of Plain Types in bore sizes 3/16" to 6" Dia. Rod end types in similar size range with externally or internally threaded shanks. Our Engineers welcome an opportunity of studying individual requirements and prescribing a type or types which will serve under your demanding conditions. Southwest can design special types to fit individual specifications. As a result of thorough study of different operating conditions, various steel alloys have been used to meet specific needs. Write for revised Engineering Manual describing complete line. Address Dept. MD-58.

SOUTHWEST PRODUCTS CO.
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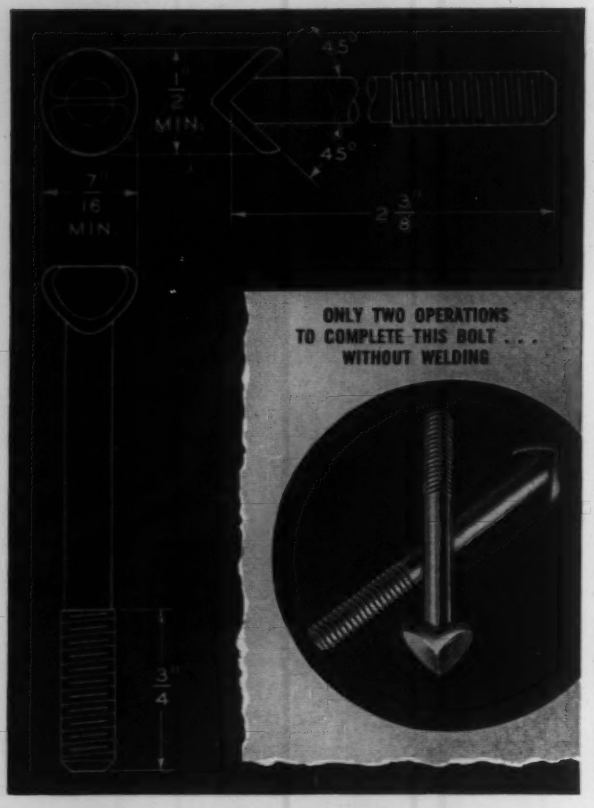


made in one piece for less

by cold heading

Functionally right for its purpose, this angle iron bolt would be expensive to produce by conventional methods. But Progressive made it by cold heading — the only practical way to produce the bolt in one piece. Only two operations—heading and threading—completed the bolt. Avoids a costly welding operation too.

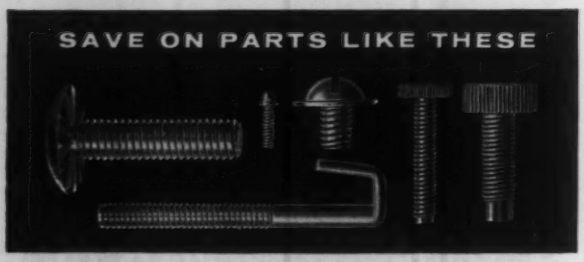
You can make savings like this with Progressive cold heading—and get naturally stronger fasteners. Write for more case histories in our *"Bank Book of Savings in Cold Heading."*

MACHINE SCREWS AND NUTS. SEMS FASTENERS. SLOTTED TAPPING SCREWS AND PHILLIPS HEAD SCREWS

THE PROGRESSIVE MFG. CO.

Division of The Torrington Company

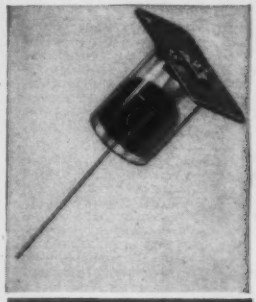
52 Norwood St., Torrington, Connecticut



AMONG OPERATIONS PERFORMED BY PROGRESSIVE are heading and extruding simultaneously; flattening; piercing; drilling; bending; pointing; fluted or diamond knurling; trimming; turning tenons, shoulders or recesses; struck or sawed slotting; notching.

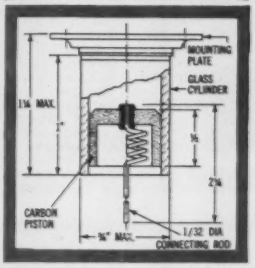
AIR DASHPOT

with Permanent Calibration



AIRPOT*

is the New Precision Dashpot, designed to meet your requirements for one-way or two-way ADJUSTABLE damping for time delay, vibration damping and stabilization. Precision bore glass tubing and carbon piston assure reliability through millions of cycles. Small in size, weighing less than an ounce, AIRPOT* units are easily mounted and adjusted.



PERFORMANCE DATA

Damping constant: adjustable up to 2.0 lbs/inch/sec.

Static and Sliding Friction Coefficient: less than 0.2

Temperature Range: from —75°C to 150°C.

Choice of cylinder lengths, and connecting rod spring gradients of 6.6, 10, 20 and 200 lbs.

Write or call for specific information

ELECTRIC REGULATOR CORPORATION / *Manufacturers of REGOHM* Regulators and MAGOHM* Magnetic Amplifiers* *T.M.

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Circle 548 on Page 19

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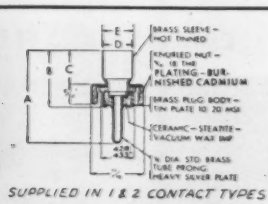
PHOTO-CELL WORK
MICROPHONE CONNECTIONS


BRASS SLEEVE – HOT TINNED
KNURLED NUT – ⅝-18 THD. PLATING – BURNISHED CADMIUM
BRASS PLUG BODY – TIN PLATE TO .20 MIL
CERAMIC – STEATITE – VACUUM WAX IMP.
.420 .432
⅛ DIA. STD. BRASS TUBE PRONG HEAVY SILVER PLATE
A
B
C
D
E

SUPPLIED IN 1 & 2 CONTACT TYPES

JONES

SHIELDED TYPE

PLUGS & SOCKETS

P-202-CCT

P-101-¼

S-101

LOW LOSS PLUGS AND SOCKETS FOR HIGH FREQUENCY CONNECTIONS

For quality construction thruout, and fine finish, see diagram above.

101 Series furnished with ¼", .290", 5/16", ⅜", or ½" ferrule for cable entrance. Knurled nut securely fastens unit together. Plugs have ceramic insulation; sockets bakelite. Assembly meets Navy specifications.

202 Series Phosphor bronze knife-switch type socket contacts engage both sides of flat plug contacts—double contact area. Plugs and sockets have molded bakelite insulation.

For full details and engineering data ask for Jones Catalog No. 22

S-202-B

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Jones — HOWARD B. JONES DIVISION
CINCH MANUFACTURING CORPORATION
CHICAGO 24, ILLINOIS
SUBSIDIARY OF UNITED-CARR FASTENER CORP.

Circle 549 on Page 19

Circle 547 on Page 19

There's a mass-market price tag on this new Realist 620 color slide projector. Easy to see why: Realist used a low-cost aspheric lens by Lancaster—for a brighter sales picture.

Want lower unit costs for your product? Let Lancaster design the glass and plastic components.

design flexibility in glass

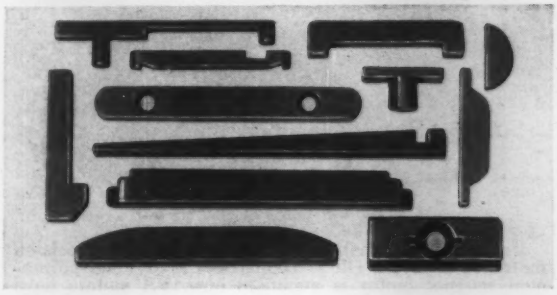
Lancaster
glass and plastics
...to brighten your product's future

LANCASTER GLASS CORPORATION • Lancaster 2, Ohio

Circle 550 on Page 19

Precision Made

GILLEN MACHINE KEYS AND PARTS



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Ask for samples by size and type

JOHN GILLEN COMPANY

Keying and Pinning Devices
2568 South 50th Avenue • Cicero 50, Illinois
A subsidiary of Standard Railway Equipment Manufacturing Co.

Circle 551 on Page 19

Some SANDSTEEL Pointers On Selecting SPRINGS *For Your Product*

Here are the two basic types of Sandsteel springs along with a general indication of the type of service they are suited for.

SPIRAL
For Ordinary Applications

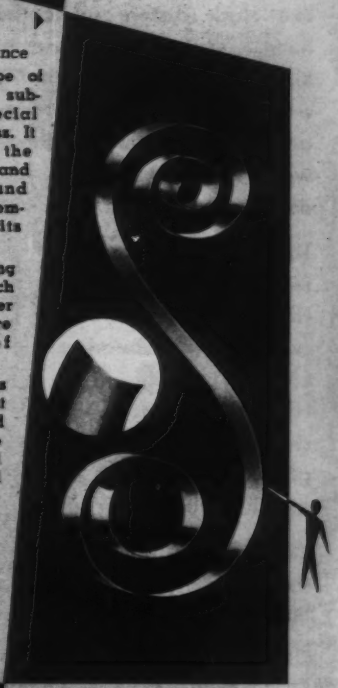
This is the common clock spring or hairspring, which can be operated within a spring drum or anchored to a post so that it will function without support around its circumference. This is the type of spring used in recoil starters for gasoline engines, guard return springs for portable electric saws, wind-up springs for toys or tension devices where constant torque is not critical.

SANDSTEEL CROSSCURVED
For Super-Performance

In this unique type of spring, the steel is subjected to our special crosscurving process. It is curved across the width of the strip and the spring is wound against both its tempered spiral and its convex curvature.

This gives the spring a dual tension—which provides dual power and a longer, more even release of energy.

This type of spring is used where constant power is required through one or more revolutions. Typical applications would be for timing instruments, carriage return springs for typewriters and office machines, power springs for motion picture cameras and other applications requiring precision power springs.



When spring performance is important, specify Sandsteel springs. Write for free literature and case history files.

SANDVIK STEEL, INC.
SANDSTEEL SPRING DIVISION
Fair Lawn, New Jersey
Tel. Fair Lawn 4-6200
In New York: Algonquin 5-2200

SS-134

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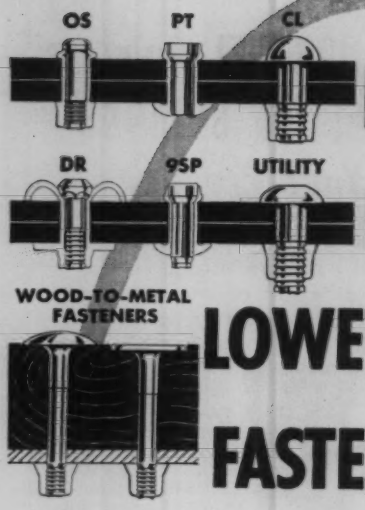


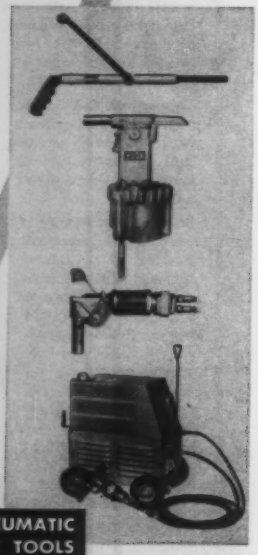
BETTER FASTER LOWER COST FASTENING !

Huck Blind Rivets and Huckbolt Fasteners are well known for their uniform, fast installation — their great strength in shear or tension and their low installed cost.

The Huck system takes the guesswork and human error out of fastening, even inexperienced operators can install Huck fasteners at a rate that makes other methods expensive and obsolete. Sturdy, light-weight tools do the work easily, uniformly and automatically.

There is a Huck fastener for every requirement — High shear, tension, self-sealing, broad-bearing, close-tolerance, pull-together, etc. Head styles, pin diameters and grip lengths to suit the specific job.

Write for catalog 8-416 showing our commercial line of fasteners and installation equipment.



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FREE SAMPLES and folder—write, phone or use inquiry service.

CONNECTICUT HARD RUBBER

NEW HAVEN 9 **CHR** CONNECTICUT

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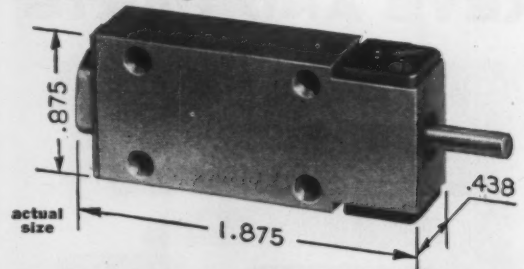
NEW FLAT MOTOR

smallest yet



Probably the smallest and most powerful precision motor of its type, Globe Industries' Model VS permanent magnet motor is available now. VS motors have flat envelopes, can be gang-mounted easily in small packages. Gear reducers can be furnished. The VS motor is designed to meet MIL specs.

Motors can be wound to produce a variety of characteristics as the application requires. Standard windings for 27 v.d.c. can produce no-load speeds of from 5,000 to 22,000 r.p.m. Line voltages from 3 to 50 volts are standard; higher voltage windings are available. Outputs to .5 oz. in. of torque at 10,000 r.p.m. are attainable. Weight is 1¾ oz. Write for Bulletin 121.

GLOBE

Globe Industries, Inc.
1784 Stanley Avenue, Dayton 4, Ohio
Telephone BAldwin 2-3741

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Save
machining costs
alloy metal costs
sub-assembly costs
trimming costs

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COMPACTED METALS CORPORATION
(Products from powdered metals)
95 Greenwood Avenue, Waukegan, Ill.

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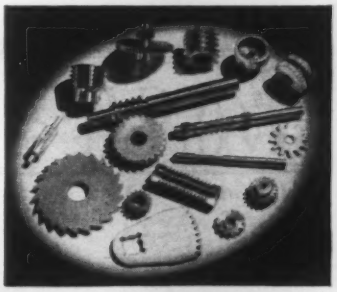
when you want precision... get

Abart



CUSTOM-CUT Gears

Abart carries no stocks. Every gear is precision-cut to the customer's specifications. Spur, spiral, bevel, helical, internal, worm, rack and sprocket—in any quantity, from any material.

Send B/P and specs or sample for quotation. 96 pitch to 5/7 D. P.—¼" P. D. to 18" P. D.

Write for Abart Gear Bulletin

ABART GEAR and MACHINE CO.
4821 WEST 16th STREET • CHICAGO 50, ILLINOIS

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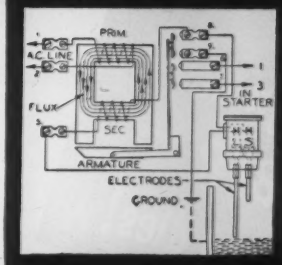
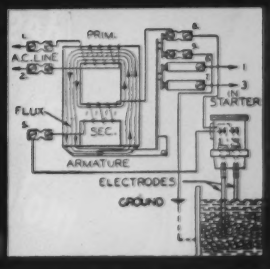
LIQUID LEVEL CONTROL with the B/W RELAY





Type LH Relay for Pump Down Control

POSITIVE AND DEPENDABLE

The B/W system of liquid level control consists of a transformer type induction relay and a holder for one or two electrodes, depending on the desired operation and the type of relay used. The relay incorporates a primary or line voltage coil connected to a permanent source of alternating current, and a secondary or electrode circuit coil connected to the electrodes immersed in the liquid being controlled. Energizing the primary coil causes an induced voltage in the secondary coil; thus the secondary coil is never connected to the power line.

LIQUID IS ELECTRICAL CONDUCTOR

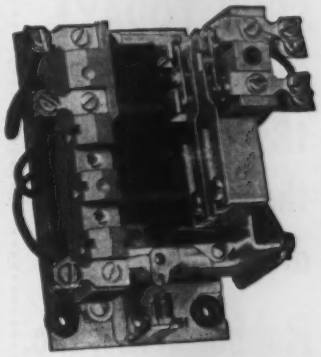
The liquid itself is the electrical conductor that completes the secondary circuit. When this secondary circuit is completed, by the liquid contacting both electrodes, the magnetic attraction set up in the legs of the relay core causes the armature to close, and open or close the load contacts. A built-in holding circuit maintains this contact until a predetermined fall in liquid level breaks the circuit. By adjusting the electrode settings, the range of operation can be controlled.

FOR PUMP UP and PUMP DOWN APPLICATIONS, SIGNALS and ALARMS

B/W relays are designed for either pump up or pump down operation. In addition, by using a single electrode they are well suited for signal and alarm applications.

NO MOVING PARTS

The complete absence of moving parts in the liquid insures long and trouble-free performance. Because of the very low current in the secondary circuit these relays are ideal for many switching jobs outside of the liquid level field.
Consult our engineering department on any special control applications.



CATALOG on request

• It covers the complete line of B/W Induction Relays, Enclosures, Contactors and Starters, Multiple Pump Controls, Electrode Holders, Starter and Relay Combinations, Special Controls and Panels.

B/W CONTROLLER CORPORATION
2180 E. Maple Road, Birmingham, Mich.

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Circle 558 on Page 19

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thousands of rubber molds and dies

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If it happens that your application calls for a unique rubber product we have years of "know-how" at your command. What ever your need, washers, gaskets, molded parts, extrusions, sheet or sponge rubber, Atlantic India is ready to serve you.

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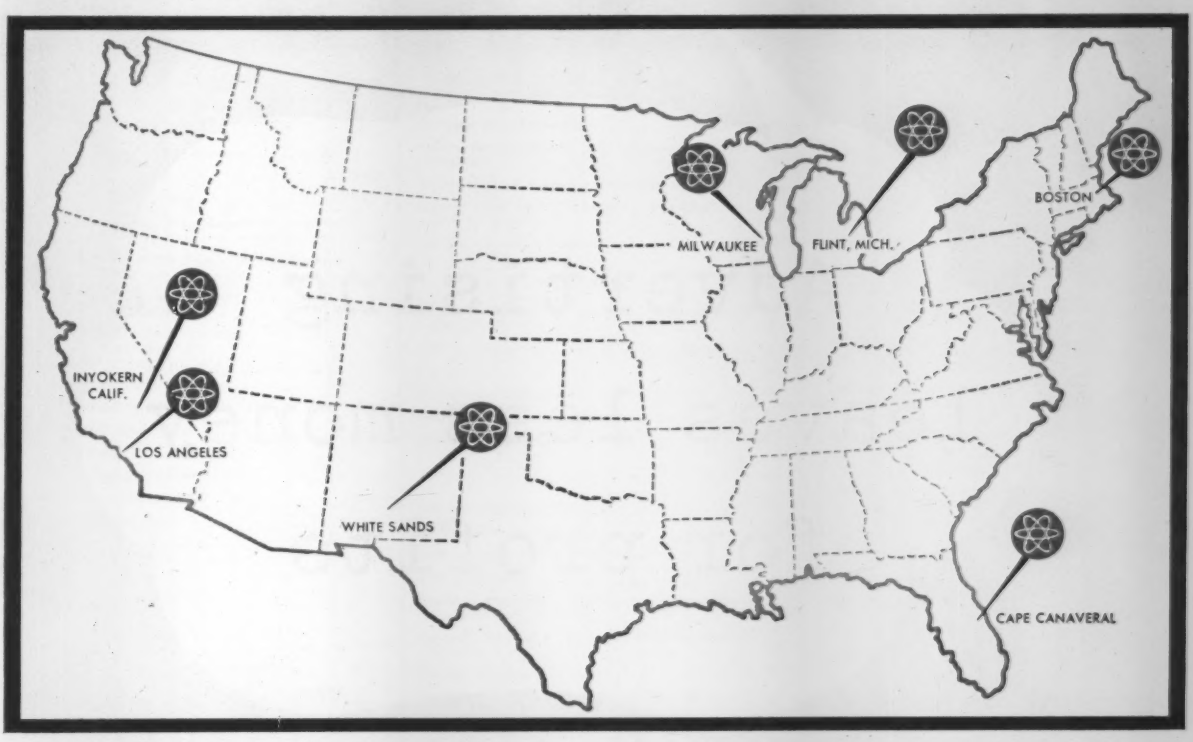
Circle 560 on Page 19

ENGINEERS AVAILABLE OR WANTED

WANTED: PRODUCT DESIGNER: Salary range $10,000. Leading nationally-known manufacturer of portable power tools has opening for Mechanical Engineer, age 28-40, for development of new tools through design, testing, and production. Experience in design of power-driven hand tools advantageous, but not essential. Must be creative and able to work independently. Excellent growth potential. Location: pleasant medium-size town. Send resume and picture, if available, to The George Elliott Co., Inc., Management Engineering Consultants (representing a client), 400 Park Avenue, New York 22, N. Y.

How far can an engineer go at AC?



Flint, Michigan; Milwaukee, Wisconsin; Boston, Massachusetts; Los Angeles, California—original design and development.

White Sands, New Mexico; Inyokern, California; Cape Canaveral—military equipment testing and field service.

Just as far as his talents, imagination and initiative will take him. He can go across the country or around the world. He can go even to top management positions. As a matter of fact, some of General Motors' Vice Presidents have come from the ranks of AC.

His career—or your career—can go up with missiles and futuristic space vehicles. For AC is building more and more of one of the world's leading inertial guidance systems—the AChiever—plus a wide variety of other electro-mechanical, optical and infra-red devices.

You can exploit your talents to the fullest degree at AC. For every AC engineer has access to the finest equipment . . . at all AC facilities.

Meanwhile, you can work on advanced degrees to enhance your professional status. AC and General Motors gladly assist further study in the first-rate engineering schools located in nearby locations.

It's doubtful whether a graduate engineer in the electronic, electrical or mechanical fields can find more diverse opportunities . . . or more challenging assignments . . . or greater professional status . . . than engineers enjoy at AC-Milwaukee.

If you are a qualified engineer, you should talk with the people at AC. Just write the Director of Scientific and Professional Employment: Mr. Robert Allen, Dept. C., Oak Creek Plant, Corner of Drexel and Howell, Milwaukee, Wisconsin; or Mr. M. Levett, Dept. C., 1300 North Dort Highway, Flint 2, Michigan.

It may be the most important letter of your life.

PRODUCERS OF: ACHIEVER INERTIAL GUIDANCE SYSTEMS • AFTERBURNER FUEL CONTROLS • BOMBING NAVIGATIONAL COMPUTERS GUN-BOMB-ROCKET SIGHTS • GYRO-ACCELEROMETERS • GYROSCOPES SPEED SENSITIVE SWITCHES • SPEED SENSORS • TORQUEMETERS

AC SPARK PLUG ⚛ THE ELECTRONICS DIVISION OF GENERAL MOTORS

Please direct inquiries to advertiser, mentioning MACHINE DESIGN

FAMOUS FALLACIES *about industrial advertising*

Advertising leaves less money for profits

J. H. Jewell refutes this one...

Mr. J. H. Jewell, vice president in charge of marketing, Westinghouse Electric Company, says: "*Well-planned industrial advertising is a cause — never just a result—of sales and profits. In today's economy the quality of communications in selling is as important as the quality of production equipment.*"

Progressive managements realize they must make effective use of all the channels of communicating with markets — salesmen, publication advertising, direct mail, trade shows, catalogs, films — if enough products are to be sold to insure full-scale employment and full use of production facilities.

Advertising has been proven to be the lowest-cost way of making up people's minds. It reaches more people, more often, with *carefully-controlled* messages.

When salesmen call on people who have been preconditioned by advertising, their task is easier, their own efforts more effective.

That is why more and better industrial advertising leads to a greater share of market preference — and greater profits.

NATIONAL INDUSTRIAL ADVERTISERS ASSOCIATION, INC.

271 MADISON AVENUE, NEW YORK 16, NEW YORK

An organization of over 4000 members engaged in the advertising and marketing of industrial products, with local chapters in ALBANY, BALTIMORE, BOSTON, BUFFALO, CHICAGO, CLEVELAND, COLUMBUS, DALLAS-FORT WORTH, DENVER, DETROIT, HAMILTON, ONT., HARTFORD, HOUSTON, INDIANAPOLIS, LOS ANGELES, MILWAUKEE, MINNEAPOLIS-ST. PAUL, MONTREAL, QUE., NEWARK, NEW YORK, PHILADELPHIA, PITTSBURGH, PORTLAND, ROCHESTER, ROCKFORD, ST. LOUIS, SAN FRANCISCO, TORONTO, ONT., TULSA, YOUNGSTOWN.

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BPA NBP

VIGILANCE

The final victory over cancer will come from the research laboratory.

But there is a more immediate victory at hand today. Many cancers can be cured when detected early and treated promptly. *Vigilance* is the key to this victory.

There are certain signs which might mean cancer. Vigilance in heeding these danger signals could mean victory over cancer for you:

1. Unusual bleeding or discharge.
2. A lump or thickening in the breast or elsewhere.
3. A sore that does not heal.
4. Change in bowel or bladder habits.
5. Hoarseness or cough.
6. Indigestion or difficulty in swallowing.
7. Change in a wart or mole.

If your signal lasts longer than two weeks, go to your doctor to learn if it means cancer.

AMERICAN CANCER SOCIETY

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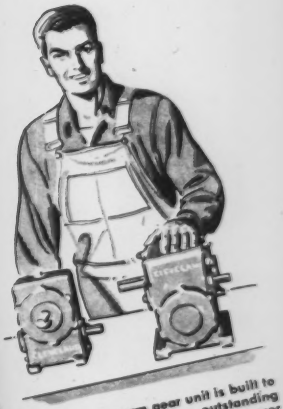

Every small worm gear unit is built to precision standards—as outstanding in quality and performance as larger size Clevelands.
Illustrated above are the 10 AT (left) and 00 D (right) speed reducers.

Enjoy the benefits of worm gear drives in smaller CLEVELAND speed reducers

WHEN you want a quiet, powerful, dependable drive for a small machine, choose a Cleveland Worm Gear Speed Reducer.

As built by Cleveland, the worm gear reducer is a drive of many advantages:

1. It is compact and inherently quiet, transmitting power with smooth, uninterrupted torque flow.
2. Its right-angled design saves valuable space.
3. It has a minimum of moving parts.
4. Shock load resistance and other factors of safety are high.
5. Rate of wear of case hardened steel worm on nickel-bronze gear is very low, insuring long life.

Write for Bulletin 114F which illustrates and gives engineering data on smaller size Clevelands—many now available for immediate delivery. The Cleveland Worm and Gear Company, 3287 E. 80th St., Cleveland 4, O.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

CLEVELAND
Worm Gear
Speed Reducers

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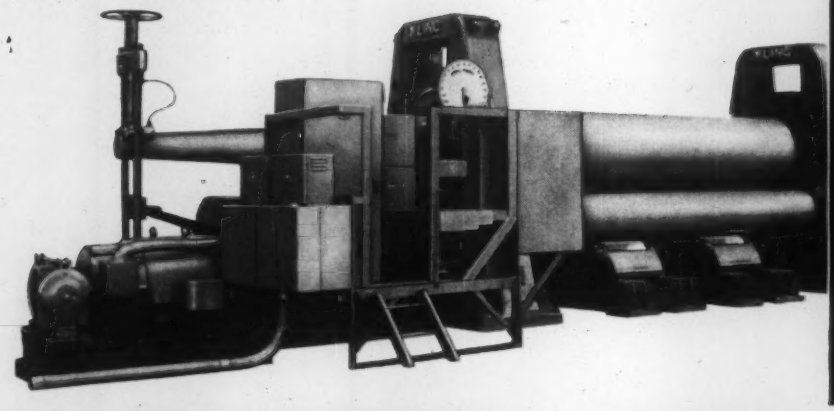
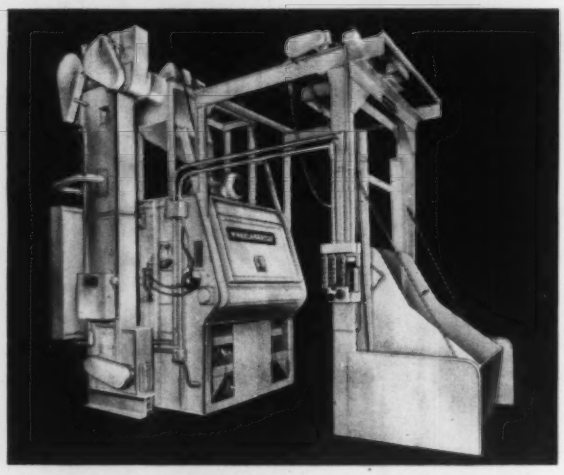
The Kling Brothers Engineering Works manufactured this steel plate bending roll for one of the leading shipbuilders . . . it's completely equipped with Cutler-Hammer Motor Control and magnetic brakes.



American Machine & Foundry Company's Glen Mixer, used by the baking and pharmaceutical industries for mixing large batches, features Cutler-Hammer Motor Control.



CUTLER-HAMMER
CONTROL
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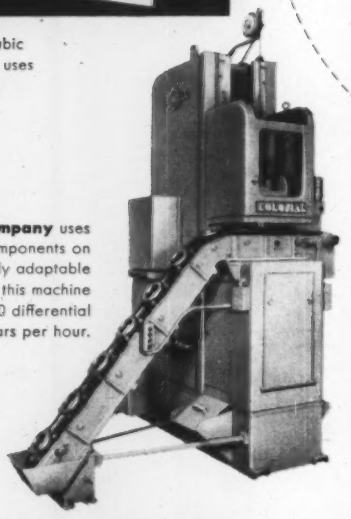
Choice of the leaders . . . the mark of better machines

The Wheelabrator Corporation's 14 cubic foot Super Tumblast abrasive blast cleaner uses Cutler-Hammer Motor Control as standard original equipment.



Colonial Broach & Machine Company uses Cutler-Hammer Control Components on their RU 15-48 model. Easily adaptable to fully automatic operation, this machine is capable of broaching 300 differential ring gears per hour.

The proper performance of any machine requires dependable, trouble-free service from the motor control which directs and protects it. This is why leading machinery builders use Cutler-Hammer Control. It installs easier . . . works better . . . and lasts longer. For prompt attention to your control requirements write Dept. U243. Cutler-Hammer Inc., Milwaukee 1, Wis.

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